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Addresses in Honor of Dean Edsall:
Harvard in Medical Education: DR. WALTER A. JESSUP 469
The Development of Clinical Subjects as Contributing to University Work: DR. EUGENE J. DUBOIS 472
The Relation of Medicine to the Fundamental Sciences: DR. LAWRENCE J. HENDERSON 477
Obituary:
Carl Barus: PROFESSOR R. C. ARCHIBALD and DR. R. B. LINDSAY. *Recent Deaths* 481
Scientific Events:
International Conference on Topology; The Fifteenth Exposition of the Chemical Industries; Advisory Council on Applied Physics; The Retiring and Incoming Head of the Bureau of Biological Survey 483
Scientific Notes and News 485
Discussion:
Power to Move Continents: PROFESSOR GEORGE W. MUNRO. *Protection from Mosquito Bites in Outdoor Gatherings:* PROFESSOR JOSEPH M. GINSBURG. *Origin of the Genus Name Ribes:* DR. FREDERICK V. COVILLE. *Faulting in the Mohawk Valley:* DR. G. R. MEGATHLIN. *North American Fish-hooks:* BIREN BONNERJEA 488
The American Association for the Advancement of Science:
Minutes of the Executive Committee: DR. HENRY B. WARD 492
Special Articles:
Further Evidence for the Presence of a Toxic Factor in Pernicious Anemia: DR. G. E. WAKERLIN and DR. H. D. BRUNER. *Some Observations on Ultra-Violet Irradiated Amebas:* W. A. BLACK. *A Contribution to the Pharmacology of Physostigmine:* CHARLES R. LINEGAR, JAMES M. DILLE and PROFESSOR THEODORE KOPPANYI 494
Scientific Apparatus and Laboratory Methods:
A Proposed Method for the Direct Measurement of Correlation: DR. BRONSON PRICE. *Denaturizing Formaldehyde:* PROFESSOR H. L. FOUST and OTHERS 497
Science News 6

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ADDRESSES IN HONOR OF DEAN EDSALL[1]

HARVARD IN MEDICAL EDUCATION

By Dr. WALTER A. JESSUP

PRESIDENT, THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

DISEASE is an ancient and ever-present enemy of man. From the beginning of history we have reports of man's struggle against disease. In the attempt to understand disease and its cause and cure, man has dabbled in every known field from religion to sociology, from astrology to chemistry, from superstition to science. The history of primitive peoples abounds in all sorts of queer stories of resort to the magic of the medicine man, of almost every conceivable explanation of the cause and cure of sickness. Ponce de Leon was neither the first nor the last seeker after youth. His prototype has existed in every age and generation. The prevailing traditions, *mores,* faiths, have been constantly reflected in man's attitude toward disease and its cure. This is true not alone for the work of the modern scientific physician but likewise for the work of ancient Greeks—Hippocrates and Galen. In this scientific age it is hard for us to reconcile the fact that at the University of Salerno, which began to flourish in the eleventh century, medicine, astrology and mathematics were the leading disciplines. For that day there was nothing incongruous in pairing astrology and medicine. In the days of scholasticism at Bologna the study of medicine was made a subject

[1] Read at a meeting in Boston, Dr. Walter B. Cannon presiding, in honor of Dr. David L. Edsall upon his retirement as dean of the Harvard Medical School and School of Public Health, October 23, 1935.

Before introducing the speakers Dr. Cannon said:

"We are gathered here this afternoon to recall and evaluate some of the services which our friend Dr. Edsall has performed for medicine. I say some of the services because he has had so varying a career, he has contributed to medicine in so many different ways, that a satisfactorily complete estimate of all he has done would be impossible in a short afternoon meeting.

"More than a quarter of a century ago his knowledge of pediatrics was recognized by his election as president of the American Pediatric Society, and by his being offered the chair of pediatrics at Johns Hopkins and later at the University of Texas. For some time he was professor of therapeutics and pharmacology at the University of Pennsylvania. Later he was professor of preventive medicine at Washington University, St. Louis. For eleven years he was Jackson professor of clinical medicine at Harvard and during that time he inspired many young

of disputation in preparation for which the study of rhetoric was an ever-present need. For hundreds of years the advocates of instruction by means of dissection fought a losing fight against faith in material resurrection. Material for disseeting has been difficult to obtain even within our own generation. For thousands of years even the simple methods of trial and error were cramped because of restrictions imposed by superstitious belief in magic, by tabus and by ignorance in related fields.

With the rise of the universities of the world, medicine came in for its share of recognition. The writings of Hippocrates, Galen and the rest were translated, the Arabian practices were studied, but for long periods the belief in the infallibility of the writings of these authorities retarded even the most simple and elemental inquiry. The mood of acceptance of authority stifled question in every form. It is only on this basis that we can explain the long delay in discovering such physiological functions, as, for example, the circulation of the blood. Until modern times the ignorance of gross anatomy and simple physiology was profound. While the university recognized medicine as a thing to be taught, along with theology and law, the fact that the method of instruction and study was for the most part identical with that of the study of theology and law is at least a partial explanation of the long-continued ignorance.

Those persons who lament the academic point of view in contrast to the application of knowledge should thank their stars that they do not have to contend with the inertia of earlier days. From the beginning disease has been closely identified with the church. Ecclesiastical and profane history abound with proof of the fact. In our own Colonial days it was not uncommon to expect the minister to render service as a physician. Casual practice was likewise very common. Physicians learned through a more or less well-defined system of apprenticeship. Reading and riding under the tutelage of a doctor was the accepted mode of making a doctor. What a haphazard method of training that was!

As early as 1782 Harvard commenced to teach medicine. Some three decades later, recognizing the necessity of a hospital connection for instruction in medicine, she moved her staff and students from Cambridge to Boston to take advantage of the opportunity for clinical material. The further settlement of the country brought a great demand for medical service, with a consequent growing economic opportunity for the doctor. It is hard for us to realize that during the past century upwards of four hundred and sixty medical schools were established in the United States and Canada. These schools were for the most part proprietary in support and sketchy in character.

At the turn of the century organized medicine, through the American Medical Association, officially recognized the confused and unsatisfactory conditions in medical education and practice and sought the help of the Carnegie Foundation for the Advancement of Teaching. Mr. Henry S. Pritchett, then president of the foundation, forthwith responded by recommending to his board of trustees that the foundation sponsor an inquiry into medical education in the United States and Canada. The Flexner report was the outcome. From that day until this the Carnegie Foundation has had an especial interest in education for the healing art. Mr. Flexner placed his finger unerringly upon the need for a sound medical education with an adequate scientific background, with ample clinical material, with competent laboratory and clinical instruction under direction that was responsible to society as a whole as distinguished from the individual doctor who might be interested in medical education for the time being or for wholly personal reasons.

The period intervening between 1910 when this study was made and to-day has been marked by a revolutionary change in social attitude toward medical practice, medical education and medical research. Weak schools have been closed and many really great medical schools have been developed. Through the

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men for their professional careers. As you probably know, he has long been recognized as a pioneer in the study of industrial disease in the United States. And he is known throughout the country as a great reformer of medical education. As dean he has done more to increase the resources and to promote productive scholarship in the Harvard Medical School than any other individual, in my opinion, except possibly President Eliot. As dean also, at the Harvard School of Public Health, he has developed that institution from small beginnings to an important agency for the assurance of public welfare.

"In all these various contacts with medical interests, Dr. Edsall has seen the profession steadily and seen it whole—in its proper place in the social order and its widening responsibilities for public health. Now in the short time available it is impossible to consider all these multifarious activities. We can consider only a few. I take great pleasure in introducing first Dr. Walter A. Jessup, president of the Carnegie Foundation for the Advancement of Teaching."

At the conclusion of the addresses Dr. Cannon said:

"The speakers have called attention to some of the more important services which Dean Edsall has performed, and we are grateful to them for the insight into the significance of these services that they have given us.

"It does not yet appear what Dr. Edsall will do with the time of his life—we hope that a long time—that still remains to him. You remember perhaps that as a young man he was interested in pediatrics. Perhaps now that he is an older man he will pay some attention to geriatrics. Geriatrics is a term that has been coined to designate the disorders of old age. Perhaps he might care to round out his contributions to medicine by starting a new specialty! Certainly it would be very pleasant if Dr. Edsall, as a geriatrician, would apply his wisdom to the care of some of us as we grow old together. But whatever activity Dr. Edsall may decide to engage in, or wherever he may go, I trust that he will carry with him the assurance that he has always our best wishes, our affectionate best wishes."

examining boards of the separate states, higher and higher standards for admission to practice have been adopted. Medical research, either in institutions of research, such as the Rockefeller Institute or in medical schools such as those at the Hopkins, Harvard and Toronto, and in departments of pure science as in chemistry, physics and biology, has dominated the imagination of the professions. Not only this, but there has been a dramatic recognition of the social significance of discoveries and new applications in the field of public health. Researches in the control of yellow fever, of diphtheria, of typhoid fever, of malaria, of smallpox, not only have contributed to the comfort of the individual person but have brought about such uniformly wide acceptance of this information by the public as practically to eliminate these particular diseases as public menaces. Great commercial interests, including industries, large insurance companies and stores, have recognized and accepted the economic importance of public health. In view of the wide fulfilment of modern plans for health service it is hard to believe that these ideas are so new. Much of the current talk of social security would have been unthinkable had it not been for the part played by public health agencies within the past quarter of a century.

Within this period we have witnessed a transformation in medical education and in standards of individual and community medical service. This has met the approval of the general public and as much cooperation on the part of the medical profession as might have been expected, but it has received its driving force from the centers of medical education and medical research and the leaders in these fields.

During these twenty-five years society has received the dividends on endowments that fostered Harvard, the Johns Hopkins, the Rockefeller Institute, the University of Chicago and other centers that have exemplified the best in modern medicine. Great sums have been invested in laboratories, hospitals or staff. The Rockefeller Boards have given tens of millions to the cause. Their immense gifts constitute but a part of the general outpouring of funds through private gift and public taxation. More dramatic things have happened in medicine during this period than at any other time in our history. Dean Edsall himself, in dedicating the Duke University School of Medicine, cited a long list of important changes that had occurred during his own active life as teacher and practitioner. Indeed, the whole atmosphere in which a doctor now works has altered from that of dependence upon the five senses to scientific acceptance of all the modern laboratory techniques. Dean Edsall has witnessed the establishing of the Wassermann tests; the control of diphtheria, hookworm and malaria; the use of the x-ray in diagnosis and insulin in treatment. These additions have been profound in their effects upon the individual practice of medicine and the program of the public in regard to health, but they have also great significance to the doctor himself.

With the recognition of the social significance of skilful medical service has come the wide-spread acceptance of the necessity for providing superior service under more favorable conditions than had been possible heretofore. Dean Edsall says that when he started to practice medicine it was unethical for a doctor to take a contract appointment, in contrast with the present growing acceptance of medical service as a social obligation on the part of many industries and indeed in not a few governmental agencies.

Licensing physicians in some form or another is by no means an innovation, but within this past quarter of a century society has taken long strides in the direction of assuring to itself competent medical service by admitting to practice only those young men who are likely to be effective doctors. The schools of medicine are now being asked to assume an even larger share of responsibility not only for training but for the selection of those who are to be admitted to the practice.

Few persons interested in medical education have perceived so clearly as Dean Edsall the importance of richness of personality on the part of the physician. Dean Edsall has emphasized in his writings and his addresses the need for the physician to preserve for his patient the warmth of human sympathy without which mechanical application of principles and laboratory techniques can avail little in practical medicine. With a great native charm he has pointed out to the young medical student the importance of a knowledge of literature, not only as a great treasure to be enjoyed, but as a means whereby the physician may achieve a better understanding of human nature. No one has insisted more clearly than he upon the necessity for exercising sympathetic intelligence and judgment in making use of reports from the laboratory.

It is easy to set up programs of public health as distinct from individual practice. Not infrequently there has been a lack of close coordination of the service of the public health worker and the physician. But through research in the control of disease, enormous advances have been made within recent years, which tend to narrow this apparent gap. Should the present social philosophy in regard to group responsibility survive and expand, it is apparent that medical education as well as medical service will be greatly affected.

The Harvard Medical School, under the direction of Dean Edsall, has been vigorous in its attempt to meet the need for public health education. He has

defined the value of sound public health policies to industry, commerce, government and society. Moreover, no one has presented more clearly the attractiveness of the possibilities of public health service. He has been a constant advocate of the importance of providing public health with a background of pure science, chemistry, physics, biology, bacteriology, as well as of utilizing every increment of knowledge turned up in the fields of economics, sociology, psychology, and the like. He has even gone so far as to advocate that many public health workers might well be sociologists, chemists, psychologists, and what not.

The Flexner report in 1910 showed Harvard to possess one of the most richly endowed medical schools of the day. During the succeeding years the Medical School has borne its rightful share of responsibility for being in the vanguard. The impact of science on medicine placed a new responsibility for the training of doctors upon the university as a whole. The coordination of the clinical and the laboratory staff has been no easier at Harvard than it has been at other institutions. From the very nature of the case the clinical man, with his laboratory material in the form of living human beings, has operated under somewhat different pressures than have prevailed in other laboratories. Few persons recognize the difficulty that clinical men have found in adjusting themselves to the academic traditions of a university. Dean Edsall has been conscious of this problem throughout his entire administration. He has made notable progress in the coordination of the clinical and the laboratory phases of medical education, not alone through the capitalization of laboratory opportunities in the various hospitals; the clinical work has been illumined by the laboratory work in Harvard College as well as in the laboratories of the Medical School itself. The complexity of the administrative problems of a medical school is not fully realized: how to utilize leadership wherever it may be found; how to encourage brilliance in unexpected places; how to remain sufficiently unconventional to give free sway to new ideas. The answers to these questions baffle every dean, but in addition to these marginal activities there is the constant necessity for maintaining the school as a going concern. The successful medical administrator has been very rare. Dean Edsall has been able to succeed in an exceptional degree. In addition to his immediate responsibilities he has associated himself closely with the leading men in this country and Europe who have similar interests. To those of us who believe in the importance of great personalities wherever found in an educational program, it is heartening to note that the new president of Harvard is committed to the policy of filling vacancies with men of promise and distinction. With such a tradition and such a policy we may expect soundness of scholarship, research in keeping with the reputation of the university, clinical skill equal to the best that is known, recognition of essential elements in a program of preventive medicine and public health education that expresses the best that can be achieved within the limits of our social, economic and political organization.

THE DEVELOPMENT OF CLINICAL SUBJECTS AS CONTRIBUTING TO UNIVERSITY WORK

By Dr. EUGENE J. DuBOIS

PROFESSOR OF MEDICINE, CORNELL UNIVERSITY MEDICAL COLLEGE; MEDICAL DIRECTOR, RUSSELL SAGE INSTITUTE OF PATHOLOGY

IT is a great personal pleasure to me that I am permitted to take part in this afternoon's tribute to Dr. Edsall. It so happens that my own interest in research was largely stimulated by Dr. Edsall, something of which he has been totally unaware. The particular medical school that I attended seemed to have little interest in anything except the preparation of men for hospital interneships. I do not think that any student was ever referred to an original article in the literature. Our diet was one hundred per cent. text-book. When I was interning at the Presbyterian Hospital, however, my chief, Dr. Francis Kinnicutt, for the first time in my career brought me face to face with an original article, and it was one of Dr. Edsall's papers dealing with typhoid fever. That started me on a study of typhoid that lasted for many years. Since that time I have frequently been indebted to Dr. Edsall's contributions and it was only a week ago that I had to consult and quote one of his articles on respiration.

Dr. Edsall was a leading member of the group of research clinicians who changed the whole atmosphere of clinical medicine in this country. His own studies were important, but I think the medical world is even more indebted to him for his share in the development of the Harvard Medical School. It is not too much to say that during the period of his deanship Harvard has taken the leading position among the medical schools in this country. The situation in Boston has been particularly fortunate, although I suppose there have been difficulties that are not apparent to New Yorkers. Harvard seems to have worked out a happy

solution of the perplexing problem of full time versus part time, combining the advantages of both systems. The research work coming from the group of institutions that constitute the Harvard Medical School has been outstanding, as evidenced by the meetings that are held in Atlantic City in May. The program always has a prevailing Boston accent.

A medical school must be judged not only by its research but also by its students. For many years I have worked with Harvard graduates as internes and residents and they have been splendidly trained. In selecting internes I have been interested in comparing the attitudes of the fourth-year students from different schools when they apply for positions. There is one excellent school whose graduates convey to you their conviction that you would be particularly fortunate if you secured their valuable services. Our own fourth-year Cornell students usually go to the other extreme. The Harvard students make you realize that they know their superior value but that they have been very thoroughly trained in concealing this fact. Please forgive the Irish bull, but it is the only way in which this point can be expressed. Perhaps it is unnecessary to say anything more about Harvard University, since it has now received eleven stars in the *Atlantic Monthly*.

The problems of medical education are as old as the hills. The first reference that I have found to a medical faculty is in the twelfth chapter of Psalms. The prayer book gives this translation of the fourth verse: "We are they that ought to speak, who is lord over us?" This surely must be a chorus from the faculty when King David was considering a change in the budget or the appointment of a new dean. The next verse was evidently contributed by the social service department, as it speaks of "the comfortless troubles' sake of the needy: and because of the deep sighing of the poor."

Throughout the course of history and until the seventeenth or eighteenth century the development of science and the practice of medicine were combined and practitioners were leaders in contributing to university work. In the last century they have fallen behind. The actual definition of university work is difficult. Certainly it is not confined to the university, since university ideals sometimes reach their highest development in commercial laboratories and research institutions. Perhaps the true university spirit is most concentrated in a place like Woods Hole, which is not controlled by any one university but represents a spontaneous and informal gathering of teachers and students.

The medical colleges have put too much emphasis on the division between the so-called pre-clinical and clinical subjects with the assumption, evidenced in this very program, that the pre-clinical departments are more closely related to the other graduate schools of the university. This is, perhaps, the natural result of the fact that such departments as anatomy and physiology have no clinical responsibilities and their duties are much the same as those in the non-medical parts of the university. Similarity of ideals is most desirable and effort should be made to bring the clinical departments more fully into this highly esteemed atmosphere. The chief difficulty lies in the fact that the clinical departments have a double duty. They must give the best possible medical care to their patients and administer efficiently large clinics with limited budgets. The care of patients is always the major responsibility and nothing could be more disastrous in the education of medical students than neglected patients.

In discussing the clinical departments it is necessary to consider not only medicine and pediatrics where research has been well supported in the past but also psychiatry, obstetrics, surgery and the many specialities which have received comparatively little attention. It is dangerous to make sweeping statements, as conditions vary in the different schools and different departments. Some of the so-called minor specialities in some of the schools have been highly developed in their research work. Surgery is taking a leading place, as, for example, at Harvard, where its contributions to physiology have been more important than those of most departments of physiology. In general the volume of research publications from the clinical departments has been large, the quality uneven, but some of it well up to the standards of the pre-clinical departments. This is evident in going over the bibliography of a man like Dr. Edsall and the clinicians of the Harvard Medical School in the period of Dr. Edsall's deanship. In order to evaluate this it is necessary to consider the prevalent opinion that work on animals is more scientific than work on man. Probably this false idea rose from the large mass of clinical reports made in past generations by clinicians with little or no scientific training. Perhaps this applies also to the great majority of clinical reports at the present time. Clinicians must live down the somewhat shady past. Nevertheless, the clinical departments of this and other countries at the present time contain a great many men who have been trained in quantitative work, whose technique is fully adequate, whose care in handling controls is up to the best standards and whose knowledge of statistical methods is duly mixed with common sense. There is not time to list the important contributions that have been made, neither is it necessary in this gathering. The clinic affords opportunities which in many respects are much better than can be found in laboratories dependent upon animals.

Nature has performed upon patients experiments that are as yet beyond the technique of the physiologist. It is the careful study of such morbid processes that give the scientific clinician his chance to advance knowledge. If his methods are as good as those of the physiologist who works with animals, the significance of his findings will be greater, since more is known about the normal standards for humans, more controls are available, more cooperation possible.

In reviews of physiology, biochemistry and immunology, a large share of the references deal with the work of clinicians. It might be said that in preparing these articles the clinicians have temporarily made themselves physiologists, biochemists or immunologists. That is because we are in the habit of putting research into certain pigeon-holes that correspond with university departments. Let us suppose that a new pigeon-hole were made and a department of pathological-physiology established in every medical school. The only way in which adequate staffs could be obtained would be to draw men almost entirely from the clinical departments. In this particular field the clinics have certainly contributed to university work. It is not the main purpose of my talk this afternoon to point out accomplishments of the past but rather to call attention to some of the defects of the present and possible methods of improvement.

Although the contributions from the clinics have been considerable the conditions are far from satisfactory and there are many departments in good medical schools that have lagged far behind, and many specialities where drastic reorganization and a complete change of spirit are necessary. The present state of affairs is partly the result of historical development. The non-medical departments of the university were built up around scholars who attracted students, and the technical training of these students was secondary to scholarship. The medical schools were built up around hospitals and individual practitioners, and their chief aim was an adequate technical training that would prepare the students for the practice of a profession. Their aims were not so very different from those of technical high schools that turn out stenographers and skilled mechanics. Upon these medical institutions in recent years was engrafted an idea of pure scholarship, research for its own sake, and a love of investigation which might or might not have practical results but would add to the sum total of human knowledge. These are the aspects of the clinical subjects that constitute "university work" as opposed to what might be called "technical school work." It was realized that if a teacher thoroughly loved his subject he would be willing to spend, in fact, he could not help spending, his time and energies in an effort to increase knowledge in that subject. Formerly the head of a clinical department was selected entirely on account of his ability as a clinician, teacher and administrator. Recently, more and more emphasis has been placed upon research, and now in many of our best schools, one of the chief, perhaps the chief qualification, is the evidence of originality in research. The man selected on this basis finds that all the older requirements must be fulfilled also. The larger part of his time is given over to the organization of the clinic, the care of patients and teaching. He has to supervise the work of a hundred or more doctors and provide for the adequate care of a large number of bed patients, as well as a huge clientele in the out-patient department. He must manage the difficult task of running his part of the hospital efficiently and economically. He must always be available for conferences with his assistants and with students. Such time as remains from these administrative tasks can be given over to the teaching and research, but he must be prepared to leave them at a moment's notice for any one of the hundred claims that are made upon a clinician who is responsible for patients. It is difficult, if not impossible, for him to continue to devote himself to a major research problem of a fundamental nature and there is usually a falling off in the quality of his work. The department depends more upon the younger men who have larger shares of free time, although in periods of stress these may be seriously limited.

The organization of the modern clinic is a combination of hospital and medical school, usually with budgets contributed from two different sources. Allowances are made for pure investigative work, but they are the most vulnerable parts of the budget and, of necessity, are greatly restricted in times of depression. Fortunately there are usually supplemental funds that have been given by generous donors for special work over limited periods. There are scholarships and research fellowships. In some cases there are affiliated research institutes. In general the departments that stand out as leaders attract more of these funds and more research fellows, but there are some sterile departments that have charge of the expenditure of research funds that are largely wasted. Relatively few of the specialties receive much support.

Clinical research is by no means restricted to the universities, since there are notable institutions, such as the Hospital of the Rockefeller Institute, which have no university connections. Some research funds are attached to hospitals where there is no teaching. Others given by wealthy donors to favored individuals have been quite barren but could, perhaps, be made exceedingly useful if they were in the proper surroundings.

The most important part of any clinic is the group

of younger men engaged in research and teaching. They are attracted to a career in academic medicine and after a long period of training are appointed research fellows or instructors and begin to wonder about the future and chances for advancement. They find themselves near the base of a pyramid which becomes much narrower in the zone of assistant and associate professors and extremely narrow when it comes to heads of departments. Inasmuch as academic advancement depends upon research the young man feels that he must devote himself to several years of research, even though his talents may be directed more toward executive work or teaching or the clinical care of patients. On the other hand, the man who wishes to devote the major part of his time to clinical investigation of a truly scientific nature does not see any possible future unless he remain always an assistant. Attainment of the conventional goal of his ambitions would take away the best opportunities for research.

This sounds over-pessimistic and there are many exceptions. But in general it is not encouraging to look over the list of publications of men after they have become the heads of large clinical departments. I shall never forget the most interesting part of my brief medical education in Germany. The laboratory was a small one and the dozents would gather in one corner and discuss their vital problems, such as whose name should stand first on a paper and how so and so who had just published an excellent new book should marry a rich wife in order that he might pursue his career in science. Once I overheard them talking about a German doctor I knew, who had been doing some splendid research work in fever. One of them said, "He has just been made professor and that means the end of his research." I could not quite understand this, as the professorship did not involve any particular increase in his executive duties or teaching. Apparently the comments indicated that since his goal had been attained he would then be satisfied. It is perfectly true that in this case the man's contributions fell off in importance within a few years. In our country the change in title makes no difference to a man who is interested in investigation. The thing that stops him is the sudden increase of executive responsibility. Recently I have had to look up the bibliographies of a large number of heads of departments and it is evident that if a chart were made of the important contributions of these men, there would be a marked drop in the curve just about the time that each man was appointed head of a clinical department. Is the appointment to a professorship the equivalent of an artificial menopause?

Up to the present time there has been relatively little careful planning for the best methods of exploration in the field of clinical medicine. Without much thought on the matter clinics have been made larger and larger, following in a general way the tendency of naval experts who have increased the size of battleships. The modern medical clinic is not unlike a battleship and the commanding officer is asked to explore in a vessel that is entirely unsuited for the purpose. Only a few explorations in the old days were made in large vessels. The most successful were in small ships capable of going up rivers, ships no larger than was necessary to make them safe for the roughest waters that they would encounter. Small expeditions go far. Polar exploration brings out this point. If one were to review it in medical fashion it would go something like this: "The North Pole was discovered in 1909 by Peary with the technical assistance of Henson and four Eskimos and his findings have since been confirmed by Byrd, and Amundsen, Ellsworth and Nobile, and Wilkins."

What is the best-sized organization for exploration in clinical subjects? It must not be too large or it will lose in mobility, flexibility and ease of management. It must not be too small or it will not be self-supporting and free from the danger of storms. These requirements can not be fulfilled by a large clinical department or by a small scholarship fund. There exists, nevertheless, a type of organization that is well adapted for the purpose of exploration in affiliation with a large clinic; a type that I believe should be much more utilized in this country. I refer to the moderate sized research funds and institutes that are attached to some clinical departments. For many years it has been my happy experience to be associated with one of these institutes, the income from which has amounted to from $12,000 to $16,000 a year. Inasmuch as it has always worked in laboratories that have been provided by hospitals, its overhead expenses have averaged about $400 a year. Its business management has required three or four hours a month. Practically all the funds and the time of the staff can be devoted to research. There are several other funds of this nature and I believe that there should be many more of them. If they were administered by the proper boards of directors they could be moved from one institution to another, depending upon the opportunities that were offered. If a certain clinical department were administered by an able man he might have affiliated with his department two or three such funds, with staffs that could devote most of their energies to research and still have time to participate in teaching and the care of patients.

Perhaps supplements of this nature are not needed in the best clinical departments where work of the highest order is already well established. I am thinking chiefly of several classes that would need such help. There are, for example, the good clinics that have

plenty of room but no funds. There are the clinics of the able administrators who happen to be incapable, themselves, of directing research, yet extremely anxious to foster research in their own departments. Finally, there are the large numbers of clinics in the specialities where the technical school type of training prevails and where the ideals of university work have scarcely penetrated. Unfortunately there are very few of the leading specialists who care to devote themselves to research. Those who have ability are lured into lucrative practice.

I am trying to visualize a department of medicine or surgery or ophthalmology or orthopedics affiliated with one or more research institutes of the nature that I have described. There would be an atmosphere of investigation and all members of the staff would be exposed to a well-trained group trying to advance knowledge in that particular field. The scientific director of the institute and the other members of the group would spend most of their time in research, though participating in the work of the clinic and teaching. Undergraduates and research fellows would be given opportunities for conducting special studies in the proper surroundings, under the supervision of a scientifically trained man with plenty of time for conferences. There would be a sense of permanency and security as long as the work was properly conducted. There would be a realization of the fact that poor work, lowered standards, unnecessary friction, would be answered by a transfer of the institute or a change in personnel. If I am not mistaken a widespread use of such institutes might have an effect in changing the requirements for the heads of clinical departments. Ability in organization, care of patients and teaching would be just as important as ever, but there would be less emphasis on the necessity of finding a man capable of original work. Of course, it is highly desirable that the head of every clinical department should have this qualification, but it is a rare qualification, almost unattainable in some of the specialities. It is hard enough for a university to find such men for some of the major clinical departments. There is great danger that universities, in their desire to meet this particular requirement, may unconsciously practice self-deception and overrate the research work of certain men who are highly desirable for other reasons. The vociferous opposition of some clinicians to research has been stimulated by their contact with men inadequately trained, attempting research chiefly for the purpose of self-advancement. Such objectors soon lose their hostility when they come in contact with the real scientist. What they resent is the attitude that research work is required from every candidate for academic position, whether or not he be fitted for it by nature and training.

I visualize a clinical department with a chief who is anxious to provide the proper facilities for investigation and who is heartily in sympathy with university ideals. If he himself can contribute it is to the great advantage of the department. He would have as associates, in addition to other members of his clinical staff, one or more directors of institutes—men who are making reputations for themselves in research, reputations that depend not on their titles as heads of clinical departments but on the quality of their work. The position as scientific director of an institute of this nature would be the natural goal of a man whose talent lay in research rather than administration.

If a development of the clinics is to be made along these lines it is necessary to consider the view-points of possible donors of funds, of university presidents, of heads of clinics and of the younger men. In normal times there are many public-spirited wealthy men who are anxious to promote research in some particular field. They are naturally apprehensive lest funds may become sterile. Suppose that you were such a donor and I were asking you to provide an endowment of a third or a half a million dollars for some investigation that was badly needed. I would suggest founding an institute with a board of directors carefully selected from leaders in medicine and education. They would be given power to affiliate the institute, for periods of five years or more, with any hospital or department where the work could be performed to the best advantage. Preference, of course, could be given to some one university. On due notice the fund could be transferred to another clinic. The scientific director of the institute would be given an adequate salary and would devote his major interest to the development of knowledge in the field to which he was assigned. The clinic would provide space and facilities, the institute take care of technical assistants and supplies. Unless I am greatly mistaken, you as donors would be satisfied that the best possible use would be made of your money.

If several funds of this nature were available in a university, the president would be able to see that they were given to the proper departments. He would make use of opportunities previously wasted and strengthen deserving clinics that needed help.

The head of a clinic could not but welcome affiliated institutes of this sort. He would realize that he himself and the members of his staff would be able to collaborate in research of a fundamental nature. He would know that if things did not turn out well the agreement could be terminated on proper notice.

Finally, it is necessary to consider the effect on the younger men who are devoting their lives to a career in academic medicine. They would be assured of a

proper training and a full opportunity of showing whether or not they possessed enough originality to conduct independent research. If they proved capable and sincerely desirous of a career in research, they could look forward to a life position as scientific director of such an institute. Those who found that their chief talents lay in the direction of teaching and administration or of private practice would select other careers. The final result in the clinics would be a diminution in the number and improvement in the quality of publications. I have considered the young men last because they are the most important, since the future development of the clinical subjects in university work lies within their hands.

THE RELATION OF MEDICINE TO THE FUNDAMENTAL SCIENCES

By Dr. LAWRENCE J. HENDERSON

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THE practice, teaching and science of medicine have never been isolated from the other affairs of men, but have modified them and been modified by them. My subject is this interaction, for I have been commanded to speak of it as it exists now and especially as it exists here at Harvard at the end of Dr. Edsall's administration under the influence of changes that he has directed. These changes are the consequence of forces and tendencies that Dr. Edsall has controlled and utilized. The changes are great, the forces strong, the tendencies by no means superficial. All three are manifestations of important intellectual and social processes which concern the university as a whole as well as its parts, and which involve both private affairs and the state itself.

Familiar facts suggest that in order to fix our ideas we may speak loosely of three periods of the interaction from and toward medicine; the first, a very long one when the influence was directed chiefly from medicine outward; the second, a period of transition strikingly marked by the influence of biology, of chemistry and of physics upon medicine; and a third recent period when actions and reactions between medicine and other human affairs are so numerous, so prompt and so intricate that we can hardly follow the chains of cause and effect. These periods are by no means distinct, but it is clear that we are living in the third.

In the beginning and until recent times the action was, as I have said, outgoing; but it took many forms, so many that we can no more than sample the facts. Under the influence of his early medical environment Aristotle turned from the philosophy of his master, Plato. Here at the outset is one action that has never ceased. Like Aristotle, Darwin was the son and grandson of physicians and it is thought that he, too, received the tradition. Also, he, like his cousin Francis Galton, or, to go to another extreme, like the critic Sainte Beuve, pursued medical studies, and in all three the influence of these studies has been noted. Again and again medicine, like the church, has provided a livelihood and so made possible an intellectual life, as it did for Rabelais, for Cardan the mathematician and for Helmholtz.

In an earlier day the path to other fields often led through the study and practice of medicine. Gilbert investigated the magnet, Redi the generation of insects, Stensen geological stratification. John Locke passed from medicine to a psychological epistemology; Sir William Petty, one of the most intelligent of seventeenth century Englishmen, to statistics and economics; Quesnay, the best of the physiocrats, to economic theory guided by an idea of economic circulation borrowed from physiology. In the seventeenth century physicians contributed more than their share to a movement of the first importance in the evolution of science—the founding of academies.

The needs of medicine have created new sciences. They directed the attention of Vesalius to the systematic renewal of the science of human anatomy, of Harvey to his researches on the circulation of the blood and, still farther afield, to embryology. They led to the foundation in Paris of the garden for medicinal plants that finally developed into the Muséum—for one long period the greatest center of natural history in the world. They led Joseph Black, a professor of medicine and chemistry at Edinburgh, to his memorable work on carbon dioxide and on calorimetry. Medicine has also provided the stimulus to new developments. For instance, it was an accidental clinical observation that suggested to Julius Robert Meyer the principle of the conservation of energy.

Medicine has formed the background of the life and thought of humanists like Linacre and of physicists like Young. In other instances, for example, in the political careers of Marat and Clemenceau, we remain in doubt and can but guess about the nature of the influence. Finally, we may note the familiar and characteristic type of the physician-man of letters. At Harvard this brings to mind the elder Oliver Wendell Holmes in the past and, in the present, Harvey Cushing and Hans Zinsser.

Gradually the influence of the more abstract sciences

upon medicine restored the balance of a one-sided action from medicine to other things and then, while some of the older tendencies waned, for a time became preponderant. The ancient world hardly knew this movement, and as late as the beginning of the seventeenth century the pseudo-science of astrology was still studied by medical students and applied in practice. For this reason the medical students of Padua, among them perhaps Harvey, attended the astronomical lectures of Galileo. Thereafter the change is unmistakable. It is implied in the work of Galileo himself and in the theoretical physiology of Descartes. It becomes manifest in the work of Sanctorius and of Stensen, as well as in Borelli's systematic application of Galileo's mechanics to physiology. It appears again and again in the seventeenth and eighteenth centuries; in the applications of the pendulum, of the thermometer and of the microscope, largely under Galileo's influence, and later in the application of the manometer to the study of blood pressure by Stephen Hales. Early in the seventeenth century the physiology of vision was renewed by Kepler and Descartes. Later the physical scientists Boyle and Hooke instituted at Oxford the study of respiration. Meanwhile, step by step, applicable chemical knowledge was acquired, and finally the discoveries of Lavoisier and of Lavoisier and Laplace established the science of metabolism on a secure foundation.

The effect of the abstract sciences on medicine was accelerated in the nineteenth century and at length became, or at least now seems to have become, the most characteristic feature of the time. In its course it has grown too complex for simple description, but I think the historical implications of the single name of Pasteur will bear out my assertion.

When some, I hope I may still say many, of us were students, the words "physics," "chemistry," "botany," "zoology" and "physiology" were safe and comfortable terms that caused no concern. We knew what they meant, and, long before Bridgman had instructed us, even possessed intuitively an operational definition of them. Physics was what B. O. Pierce and others of his guild did and taught and physiology what Henry Bowditch and his guild did and taught. There were indeed signs of change, but they passed unheeded. Thus the growth of the science of physical chemistry seemed to be nothing more than an immigration into a new field that was destined to preserve its independence. Perhaps, among our elders, the word "biology" was already giving some concern to conservatives, for Farlow, a doctor turned botanist and a great Harvard worthy, used to say, wittily and not without feeling, that a biologist is a zoologist who teaches botany or a botanist who teaches zoology. But the sciences still seemed to be independent. They are so no longer; *laissez faire, laissez passer* is the order of the day in science, and the skilful workman may construct what he pleases and seek his materials almost at will. For instance, organic chemists, under the influence of physiology, have returned to the study of natural products. Not without certain temporary inconveniences the guild economy of science is decaying and is being replaced by a system that is more free and, in some few respects, less disciplined. Perhaps the chief cause of this change is that the frontiers of science, formerly several and natural like our early western frontier, have become joint and artificial like those of Europe, and that real interests and prejudices which tend to preserve them are weaker than the opposing forces of initiative and invention.

Nevertheless, the separation of the sciences remains and it is hardly conceivable that it can disappear. The indispensable needs of skill and method endure and I think we may count upon them not only to preserve in the future much that is left of the guild system, but also to restore the discipline that may have been occasionally lost with the disappearance of certain elements of the older traditional training and standards of our fathers.

Let us not, however, prophesy. We are interested in facts, and the novel relations between the sciences are very imperfectly described by what I have said, for these relations are by no means of a random character. On the contrary, they still manifest, with all their increasing complexity, the trend that was so plainly evident during the nineteenth century, and they are in general only weakly transitive.

I am concerned to make this clear and therefore ask you to consider the following list of subjects: mathematics, physics, chemistry, physiology, pathology, medicine, epidemiology, hygiene. Is it not evident, in fact, does not every one know, that on the whole, and saving the exceptions, the influences that now exist are, as they have been in the past, in one direction rather than the other in the order of the list; from chemistry to physiology, pathology and medicine rather than the reverse? Is not the above-mentioned influence of physiology on organic chemistry a little different from the usual run of events? Further, is not the influence frequently from one subject to the *next* following subject, rather than directly to a later subject? Is it not from chemistry to physiology rather than to pathology or to medicine directly? Moreover, is it not in general from a more abstract to a less abstract subject, and again from an older and more highly developed science to one that is younger and less developed, and finally, of course, from a pure science to an applied science?

In short, there is activity everywhere and in every

direction actions and reactions run on. This is all very confusing, but yet we see clearly enough that the actions, if far from uniformly, are on the whole, or at least in many cases, polarized and that there are several predominant tendencies which result in this polarity: actions from the pure to the applied sciences, from the older to the younger, from the developed to the undeveloped, from the abstract to the concrete, from one neighboring science to another. So much we can see, but we can hardly foresee the particular actions and reactions of even the immediate future, least of all perhaps in the domain of medicine and the medical sciences.

Such conditions make the task of guiding the evolution of medicine in a university difficult. They also impose limits within which it is probably bound to proceed.

In 1918, when Dr. Edsall took over the work of dean, many of these new conditions, especially the immaterial and intellectual conditions, in which the practice, the teaching and the science of medicine are evolving, were already present. But great organizations change slowly, and the formal structure of the University and of the Medical School still corresponded, in part and especially in externals, to the obsolescent guild economy of science. Material signs of this were and still are the isolation of the Medical School from the rest of the University and the planned isolation of the departmental laboratories within the school. But such external obstacles to free intercourse are no more than inconveniences when other conditions are favorable. What was important was the accompaniment of no little intellectual isolation which had already become a sensible disadvantage.

The new dean was well prepared to feel, and therefore to perceive, the effects of this state of affairs, for he had already experienced them concretely in his own work in medicine, especially in the application of chemical methods beyond the routines of diagnosis, in experimental clinical studies in the hospital, and in the application of the methods of experimental medicine to the study of industrial hygiene when pursuing investigations of occupational diseases in the factories and plants where they originate. This experience must have been of good service, while he was making decisions and working out the main lines of an administrative policy that has been from beginning to end realistic, empirical and intuitive, and has therefore led to a continuous adaptation to the changing conditions and needs of the times. Happily the great DeLamar bequest, munificent grants from the Rockefeller Foundation and many other gifts have made possible the execution of this policy.

One of the early results of his action as dean was the School of Public Health, a new department, which from its foundation has borne a relation to the Medical School and other parts of the University that might easily be mistaken for the result of a long period of adaptation rather than of a new establishment. Let us look at the facts. Administratively a separate faculty, this school has never, from the very beginning, been really cut off from the Medical School in respect of staff and researches; for administrative independence, while preventing undesirable constraints, has favored desirable connections and facilitated all sorts of mutual aid. Thus, an ever-changing nexus of connections has grown up. This has extended farther afield, in a manner suggestive of the Hippocratic treatise on "Airs, Waters and Places," to the Children's Hospital, for example, in the study of the hygiene of infants; to the Fatigue Laboratory, for example, in the study of the effects of temperature and pressure; to the Dental School, for example, in the study of nutrition; and, notably, to the Engineering School, where conditions have arisen that well illustrate some of my introductory remarks.

Sanitary engineering has reduced the control and protection of the water supply to a routine, and even in part crystallized the routine in rule of thumb. It is now turning its attention to the air. The problems thus raised have led to a valuable collaboration in research between the Schools of Public Health and Engineering, and in the application of both the physical and the biological sciences to the problems of hygiene in a manner that is obvious enough. But it has also led to other interactions and collaborations of a character that could hardly have been foreseen. Such results, I repeat, depend upon the absence of constraints of the kind imposed by rigid organization and the guild system of science, and upon the presence of connections that grow up spontaneously when conditions favor free intercourse. It is an induction from experience that a necessary condition for the best kind of collaboration in scientific work, except in the relations of master and apprentice, is that those concerned should desire to study a problem and that, because of its nature and scope, they should be unable to do so severally and independently.

In the prosecuton of research the relations between the Medical School and the School of Public Health are similar but far more extensive than those that have been established between the latter school and the School of Engineering. They are the sign of a new period within the Medical School as well as in its wider relations.

For some years there has existed at Harvard a Committee on Industrial Physiology, appointed by the corporation. Dr. Edsall has been the chairman, and among the members have been the dean of the Business School and the former dean of the Bussey Institution.

This committee is charged with the administration of a large grant from the Rockefeller Foundation. Its authority is derived directly from the corporation. It carries on independently of all faculties and departments of the University and its sole responsibility is to see to it that the work done under its supervision shall be well done and that it shall be of such a character as to conform to the liberal terms of the gift.

This committee has voted funds in support of certain researches that are now going on in the University, such as those of the functional anthropologists, of the Psychological Clinic and of the International Expedition to Chile led by Dr. Dill. The committee administers all the funds of Professor Mayo's Department of Industrial Research in the Business School and all those of the Fatigue Laboratory.

In making plans that led to the establishment of this broad undertaking Dr. Edsall took a decisive part and I think that we can see how these plans are the outgrowth of his earlier policies and experiences. His own studies of industrial medicine were a first step in the direction of sociology and the foundation of the School of Public Health went much further in the same direction. Now these are the common features of the studies that have been supported by the Committee on Industrial Physiology; they are all concerned with problems that may be considered, in the broadest sense, sociological, or else with problems whose solutions appear to be necessary as a means of making progress in understanding the conditions within which social phenomena occur. In each instance the work is carried on by men who have acquired some special skill in the use of appropriate scientific methods, including statistical, chemical, physiological, psychological, anthropological and clinical methods. In every case these men have come, independently, to desire to investigate the problems in question. In general, each is interested in the work of many of the others, so that there is much intercourse and every useful mutual aid and collaboration. Evidently all this work is, on the one hand, the outcome of the special scientific interests of those concerned and, on the other hand, a result of the many unforeseeable interactions between the different sciences that are so striking a feature of our times. Also, it is, so far as I know, in no single instance something imposed as a deduction from a great rationalized project. I believe that it is for these reasons that the results have been thus far satisfactory to the investigators and not uninteresting to others. The influence of this work has extended into the Business School and into the Cambridge departments of anthropology, psychology and sociology.

Meanwhile, the opportunity for direct influence of the more abstract sciences on those of the Medical School has been provided. Ever since the foundation of the School of Public Health a professional mathematician and mathematical physicist has held the chair of vital statistics. Also, an experimental physicist has been a regular officer of the Cancer Commission. Many other factors have strengthened the influence of the abstract sciences. A department of physical chemistry has been established in the Medical School, Professor Fiske's laboratory has become almost a laboratory of organic chemistry and chemistry has infiltrated at other points. Finally, there has been no little collaboration with members of the Division of Chemistry of the Faculty of Arts and Sciences.

The relations between the Medical School and the Division of Biology of the Faculty of Arts and Sciences are somewhat different, because the various fields of biology at Harvard, as in most other universities, were formerly divided between the two faculties. This separation, which long remained as an anachronism, has now been largely overcome. The growth of medical zoology and the importance of the ecological and other aspects of tropical medicine on the one hand, and, on the other hand, the presence of Professor Redfield, for years a professor in the Medical School and now director of the Biological Laboratories in Cambridge, the presence of others from the Medical School and the rapid growth of physiology in Cambridge have established intimate relations where once there was almost none. Lastly, we may note the recent addition of an economist to the Faculty of Medicine.

Meanwhile the relations between the laboratories of the Medical School and those of the great Boston hospitals have been almost transformed. Where formerly little more than routine pathological anatomy supplemented clinical observations, now clinical researches employing refined chemical and physiological methods are the rule. To mention only one instance, the investigations of Professor Gamble have contributed not only to medicine and human physiology, but also to general physiology.

The influence of these developments upon the practice of medicine is great. They are known to most of you better than to me. But what of medical education? From the beginning of his administration President Lowell was interested in changes in the course of study and methods of teaching and examining in the Medical School which have been slowly adopted and which are the expression of the very tendencies that we have been considering. To this I can testify because I clearly remember parts of a conversation with him that is now more than a quarter of a century old. Some of these changes were accomplished before Dr. Edsall became dean. The others, entirely accordant with the dean's sentiments and

opinions, were accomplished with the president's support, for here as in other respects, there was perfect accord between the two executives.

In another direction the initiative came from Dr. Edsall. Since it is the growth of the sciences that has given rise to all the changes that we have considered, it is not surprising that the same cause should have modified the problems of college education for the future medical student. Signs of the new conditions became clear long ago, and I remember a still earlier conversation with President Eliot, when as a young instructor I tried, prematurely and probably with little success, to argue that college undergraduates had need of information about the new relations between chemistry and biology and medicine. At the beginning of the century little was to be done, but by the twenties the problem had become serious. Nearly ten years ago it led, on the initiative of Dr. Edsall, to the establishment in Harvard College of tutorial instruction that was carefully designed to meet the need. This experiment has prospered, and from the early years of college to the end of their medical education, it has already enabled many students to prosecute and organize their studies more broadly and with a better understanding of their needs and of their intellectual interests. Moreover, the presence of a group of young and able medical men among the corps of tutors in Harvard College has greatly strengthened the interactions between the two faculties. It has also established a balance among the biological activities of the Faculty of Arts and Sciences that American physiologists have long admired and envied in the University of Cambridge and that formerly was unattainable here. The appointment of one of the tutors, Professor Ferry, as Master of Winthrop House, is a significant result of this change.

So much by way of chronicle. But the chronicle is not enough, for in ending we must try to seize the continuous threads that run through the events.

Edsall's administration is a period of transition. I have tried to suggest that it is especially marked by the application to University policy of the two principles of *laissez faire* and of *laissez passer* that were already evident in the evolution of medical science. A conspicuous result has been the strengthening of old relations and the formation of many new relations within the University. The influences of *laissez faire* are, perhaps, chiefly attributable to spontaneous forces, but it is in great part the dean who, by applying the principle of *laissez passer,* has made the intercourse and the interrelations possible and, above all, it is the man himself who has promoted that spirit of good will and mutual aid in collaboration which is to-day one of the most fortunate traits of Harvard.

OBITUARY

CARL BARUS—1856–1935

IN the death of Carl Barus on September 20, 1935, Brown University lost a brilliant scholar and investigator, long internationally famous, and a beloved colleague who for forty years had ever been among us a source of inspiration. Although he had attained to nearly fourscore years he walked in our last commencement procession. But during that very week he underwent an operation from which after a gallant summer-long struggle he appeared to rally; the end finally came with startling suddenness.

Both of the parents of Professor Barus were Germans, who at different times had come to this country and finally settled in Cincinnati, where they were married. Their eldest child, Carl, was born there on the nineteenth of February, 1856. His early years were spent in an atmosphere of music, since his father, a leading musician of Cincinnati for more than twenty-five years, was director of numerous musical organizations and undertakings. Rehearsals were constantly held in his home, and his knowledge of certain operas and other music became minute; already before his teens he improvised much on the piano and composed sonatas in the style of Mozart. Later in life he devoted considerable time to composition, and the forty resulting works included a "March to Pembroke Hall," which was published in 1905. In 1874 he graduated as the silver medallist from the then notable Woodward High School, in the same class with William Howard Taft. Already his seethingly active mind was reaching out in various directions. With books and a telescope he acquired wide knowledge of the stars; an elaborate plumber's establishment offered the opportunity for considerable acquaintance with machinery and the tempering of steel; he experimented in a chemical laboratory which he had set up in his own home; he and a chum explored the flora cincinnatiensis and had a herbarium of about a thousand plants; he obtained a basic command of literary and scientific German, later to stand him in good stead.

In 1874 he became a student of mining engineering at Columbia University, but towards the end of his second year, his interest in pure science had become intense in the same degree that the allurements of engineering had waned. A college physical laboratory had not been thought of at Columbia at that time. For the next four years he carried on research in physics under Kohlrausch at Würzburg and received

[1] Minute spread on the Faculty Records of Brown University, October 1, 1935.

in 1879 the degree of doctor of philosophy, *summa cum laude*. His dissertation dealt with the questions of the determination of the relations of hardness of steel to its electrical and thermoelectric properties and to its magnetization. During the last years at Würzburg, young Barus organized a trio for cello, violin and piano, with himself at the piano, and the resulting performances of works of Haydn and Beethoven were highly acceptable. To the horror of Kohlrausch he also took lessons on the organ at the Königliche Musikschule. After his promotion as doctor he continued research at Würzburg until word arrived of an opening in the newly organized physical research section of the U. S. Geological Survey, of which the greatly gifted Clarence King was then director.

In July, 1880, Dr. Barus was appointed in charge of the purely physical work of the survey, and the first laboratory was in Nevada. The results of his research on such topics as electrical activity of orebodies and the relations of earth temperature and depth as found in shafts of different mines, soon appeared in print. Great varieties of research followed and were carried on in different places, New York, New Haven, Philadelphia and Washington. Through the unfortunate withdrawal of government grants Dr. Barus's connection with the survey was terminated in 1892, after twelve years of service, when he was in the midst of research which Lord Kelvin and others had pronounced to be of great importance. This period was not wholly devoted to notable scientific achievement; in 1887 he married Miss Annie Gertrude Howes, whose distinguished abilities, diversely employed outside of her home, in the service of college, city and state, are well known to this faculty. Also their son and daughter were born before the end of 1892. Dr. Barus was elected a fellow of the American Academy of Arts and Sciences in 1890 and a member of the National Academy of Sciences in 1892—the youngest man who had ever been so honored. During 1892–93 he was professor of meteorology at the U. S. Weather Bureau and in 1893–95 physicist at the Smithsonian Institution, assisting Langley in his experiments with flying machines, while carrying on much more absorbing research in physics. Various tentative calls to educational institutions were received, but the invitation by President Andrews, in May, 1895, to come as Hazard professor of physics to Brown University, to succeed Eli Whitney Blake, was the one to be accepted. He was then thirty-nine years of age and had published in the United States, England and Germany more than ninety papers treating of extraordinarily diverse topics. Ostwald and others agree that his paper on colloid silver, published shortly before coming to Brown, marked him as one of the founders of colloid chemistry.

Professor Barus taught for thirty-one years at Brown University and he became emeritus professor of physics in 1926. In 1903 he was appointed the first dean of the graduate department of the university, and his reports to the president during the succeeding twenty-three years reflect notable development and present many interesting passages, in finely expressed, vigorous English. His scientific research at Brown was incessant, and his published output of some 350 articles and monographs from 1895–1929 can only be regarded as tremendous. As a result, his honors accumulated, but only a few may be mentioned. He was a corresponding member of the British Association for the Advancement of Science; an honorary member of the Royal Institution of Great Britain, of the First International Congress of Radiology and Electricity at Brussels in 1905 and of the Physikalisch-Medizinische Sozietät at Erlangen; he was a member of the American Philosophical Society, and the fourth president of the American Physical Society in 1905 and 1906; with Woodward and Michelson he was a member of the advisory committee on physics appointed in connection with the organization of the Carnegie Institution of Washington, which later made many grants in aid of his research projects. In 1900 the Rumford Medal was awarded to him by the American Academy of Arts and Sciences for his researches in heat. He received honorary degrees of doctor of laws from Brown in 1907 and from Clark in 1909. He was a member of the group called together for organizing the National Research Council, and was active throughout the great war in his aid of the U. S. Government. In 1903 the physicists of America rated Professor Barus as second only to Michelson among all physicists of the country.

Merely a casual glance through the list of Professor Barus's papers impresses one with his amazing versatility, running as it did the whole gamut of the experimental physics of his time. Although not primarily a theoretical physicist, he was one of the few men who seemed equally at home in both realms of physical science. About the turn of the century he became particularly interested in the various phenomena connected with ionization in the atmosphere and his papers in this field attracted considerable interest and helped to focus attention on what has since proved to be an all-important tool for the investigation of atomic structure. In 1910 he began a series of researches on interferometry and from then until he stopped his scientific work in 1929 devised numerous important applications of his so-called displacement interferometer to measurements in spectros-

copy, gravitation and acoustics. He was a genius in the construction of apparatus and made with his own hands most of that used in his researches. It is interesting to speculate what his achievement might have been had he been fortunate enough to have had at his disposal even a part of the elaborate equipment of some of his contemporaries, to say nothing of that of the present-day experimentalist.

At Brown University Carl Barus and Alpheus Packard are undoubtedly the most eminent scientists who ever occupied faculty chairs. Professor Barus was a hero-worshipper, and in his home was a "genius corner" from which pictured faces of great scientists looked down upon him. He rejoiced in contacts with youth and had the great gift, in association and writing, of capturing the love of children. The breadth of his interests and achievements was extraordinary—recall his reading of Greek tragedies in the original, his knowledge of French and Italian literatures, and the proficiency he attained in playing violin, flute, clarinet, oboi, cornet, trumpet and trombone, in addition to the piano and organ. The brilliancy of his intellect, the modesty of his bearing, the beauty of his personality and the kindliness of his spirit have left most precious and inspiring memories with students and colleagues of forty years.

R. C. ARCHIBALD
R. B. LINDSAY

RECENT DEATHS

DR. DAVID C. GILLESPIE, professor of mathematics at Cornell University, for several years editor of *The American Mathematical Monthly*, died suddenly on October 13 at the age of fifty-seven years.

DR. ALBERT E. ROUSSEL, emeritus professor of medicine in the Graduate School of Medicine at the University of Pennsylvania, died on November 2 at the age of seventy-two years.

A CORRESPONDENT writes: Dr. Anna Laura Hintze, assistant professor of physiology and hygiene at Goucher College, who died on October 27, was a native of St. Louis. Dr. Hintze received her undergraduate and graduate degrees at the University of Wisconsin. For three summers she was a member of the staff of the Chesapeake Biological Laboratory at Solomon's Island, Md. She was a member of the American Ecological Society, of the American Zoological Society, the American Association for the Advancement of Science, Phi Beta Kappa, Sigma Xi and Sigma Delta Epsilon.

AN Associated Press dispatch reports the death on November 8, from the bites of ticks inoculated with typhus virus, of Dr. Jose Lemos Monteiro, of the Butantan Institute at São Paulo, and a week earlier that of his assistant, Dr. Edison Souza Dantas.

SCIENTIFIC EVENTS

INTERNATIONAL CONFERENCE ON TOPOLOGY

THE first International Mathematical Conference on Topology was held in Moscow from September 4 to 10 by the Mathematical Institute of the university. A similar Conference on Tensor Analysis and its applications took place a year ago, so it seems that the University of Moscow plans to hold a series of conferences on special fields in mathematics. The characteristic feature of these gatherings is that a small group of Soviet and foreign scientists come together for a few days, present full-length papers rather than the short summaries which a general mathematical congress would necessitate, and have abundant opportunity to discuss recent developments in their specialty. The conference this year was attended by a large proportion of the active topologists of the world, including the dean of topologists, Poul Heegaard, of Oslo, and also some very young men. Fifteen of the foreign delegates came from Europe and ten from America. These included van Kampen and Zariski, of Baltimore; Garrett Birkhoff, Stone and Whitney, of Cambridge; Paul Smith, of New York, and Alexander, Lefschetz, von Neumann and Tucker, of Princeton.

The foreign delegates were warmly welcomed and every comfort was placed at their disposal. This shows indisputably that the Soviet government wishes to promote pure as well as applied science, for topology would be difficult to justify to a strict materialist. One whole day as well as periods between the almost continuous lectures were occupied by sightseeing excursions arranged by VOKS (the Society for Cultural Relations with Foreign Countries) with a view to exhibiting the new Russian culture. The foreign visitors received tickets for the theater festival then in progress in Moscow, and were entertained at several receptions, one of which was almost a state banquet.

The participants all agreed that the conference was extremely worth-while. They expressed their gratitude to the mathematicians and officials of the U. S. S. R., and particularly to Professor Paul Alexandroff, who had taken the leading part in planning the conference. G. B.

THE FIFTEENTH EXPOSITION OF THE CHEMICAL INDUSTRIES

THE Fifteenth Exposition of the Chemical Industries will open at Grand Central Palace, New York,

during the week of December 2. This series of chemical expositions has extended over a period of twenty years, and is considered to have been an incentive in advancing the manufacture of American chemicals and the necessary appliances for producing them.

Dynamic displays with processes and machines in actual operation, and the correct use of color as a feature of the construction of exhibits will be emphasized, and it is planned to give greater attention to the type of personnel in attendance during the week of the exposition. In many cases the highest officials of the exhibiting companies will be in attendance.

In the section devoted to chemicals and chemical products there will be exhibited samples of organic liquids obtained from polymerization of gaseous hydro-carbons, and a display of aromatics such as benzol and xylol made from petroleum gases. Progress of technology in the petroleum refineries will be reflected in exhibits of organic chemicals and solvents most of which formerly were obtainable only from the processes of coal distillation.

The section devoted to instruments of precision will offer the latest in this field. Of particular interest will be a device known as a valve-precisor, an auxiliary control device which when mounted on a diaphragm valve is capable of positioning precisely the valve disc in positive accordance with the dictates of the controller. There will also be important exhibits for manufacturing plants that can use simple low-maintenance pH control; portable glass electrode potentiometer sets and high-speed photo-electric action pyrometers.

Under the heading of chemical treatments for the removal from solutions of such physical characteristics as taste, odor, discoloration, cloudiness and sediment, there will be a number of processes on display. Laboratory equipment will be the subject of many new exhibits, including installations for industrial laboratories and colleges and also for government and state departments. The materials handling section will include single stroke lift trucks, multiple-barrel trucks, skids, barrel racks and electric portable elevators. One of the new items will be an electric, direct-motor-drive, portable elevator with all the gears totally enclosed and running in oil. The section of plant equipment it is said will contain an unusually large and interesting display.

All matters of arrangement and exhibit space contracts are in charge of the International Exposition Company, which has directed all previous chemical expositions. Charles F. Roth is again personally in charge.

ADVISORY COUNCIL ON APPLIED PHYSICS

A NATIONAL Advisory Council on Applied Physics was inaugurated on November 16 by the American Institute of Physics. The council held its first meeting in Pittsburgh in conjunction with an open Conference on Applied Physics sponsored by the University of Pittsburgh and held at the University Club the day before. The council embodies an effort by the several American societies of physicists to facilitate application of the fundamental principles and discoveries of the science to commercially valuable products and services.

A statement from Dr. Henry A. Barton, director of the American Institute of Physics, reads:

> The council meets a long-felt need in the science to bridge a gap between "academic" or "pure" physics and the well-known physical applications: electrical engineering, mechanical engineering, geology, etc. As physics has developed in America, emphasis has been placed on fundamental discoveries and principles rather than the immediate use of these. This has resulted in tremendous activity of far-reaching ultimate importance. American physicists and laboratories have been and are renowned throughout the world for their pioneering and exhaustive studies with radium, cosmic rays, x-rays, atomic and molecular structure, electronics, electric discharges and many other laboratory phenomena. The names of Pupin, Michelson, Millikan, Compton, Langmuir, Coolidge, Bridgman and many others spring to mind.
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> When divisions of physics have become useful, they have branched off and it is forgotten by many that they are physics. Recent examples are radio, refrigeration and aviation. But boundary lines between sciences do not really exist in nature and in all sciences and technologies new problems constantly arise which can only be solved by going back to the fundamental principles of physics itself. It is this service of physics to its applications and derived sciences that has been neglected and that the council aims to stimulate.
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> The council's problem is to decide how this can best be done. The problem divides itself naturally into three parts:
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> (1) How should men be trained for the practical application of physics; *i.e.*, what college and graduate school courses should they take and what kind of research theses should they submit for their degrees? The council will submit suggestions to universities in this connection.
>
> (2) How can learned and professional societies help? In physics there are five such societies of national scope: the American Physical Society, the Optical Society of America, the Acoustical Society of America, the Society of Rheology and the American Association of Physics Teachers. They publish journals of research and hold meetings for the presentation of scientific papers. The council will study what kind of papers should be published and read to be of most use to applied physicists.
>
> (3) What industries are unwittingly in need of the special services of physics? Industries generally are not backward in securing the best technical advice obtainable but it is believed that there should be a considerable expansion of their use of fundamental physics. The council will survey the situation and bring the opportunity to the attention of those industries not already well aware of it.

THE RETIRING AND INCOMING HEAD OF THE BUREAU OF BIOLOGICAL SURVEY

JAY N. DARLING, chief of the Bureau of Biological Survey, relinquished his post on November 15 and has resumed his work as a cartoonist. He will be succeeded by Ira N. Gabrielson, now a consulting specialist to the chief of the bureau and assistant chief of the Division of Wildlife Research and for the last few months executive assistant to the Division of Scientific Research.

Mr. Darling, in accepting Secretary Wallace's invitation in March, 1934, to become chief of the survey, did so with the understanding that it would be for only a short time. He has continued with the Department of Agriculture long beyond the period originally contemplated, and leaves now only upon the insistence of the outside interests to which he is obligated.

Mr. Darling will continue to be active in efforts to bring together the multitude of wildlife groups of the United States into what he considers a most essential organization—a national federation of wildlife organizations. In a recent statement he says: "I have come to realize that most of our wildlife conservation troubles are due to lack of organization among those who are interested but ineffective in the conservation of wildlife. There is no mass strength to enforce adequate legislative and executive attention to wildlife interests. Every other element of American life has a national organization to get effective results. Wildlife interests remind me of an unorganized army, beaten in every battle, zealous and brave but unable to combat the trained legions who are organized to get what they want."

Mr. Darling joined the department in March, 1934, after having served for three months on the President's Committee on Wildlife Restoration. This committee recommended the immediate acquisition of five million acres of submarginal agricultural land in forty-four states, and the gradual acquisition of an additional eight to ten million acres for wildlife production and related purposes. Prior to that he had gained national recognition as a leader in wildlife conservation and restoration as a member of the Iowa Fish and Game Commission, of the Iowa Planning Commission, of the Migratory Bird Conservation Commission of the U. S. Department of Agriculture, National Association of City Planners, Des Moines City Planning Commission and of the Des Moines Park Board.

As chief of the Bureau of Biological Survey, Mr. Darling began putting into effect the program recommended by the President's committee. He obtained funds for the Government's effort to establish wildlife refuges. He reorganized the bureau for more effective prosecution of research, education and law enforcement.

Mr. Gabrielson has been connected with the bureau since October 1, 1915, when he was appointed assistant economic ornithologist to conduct field research in the food habits of birds. Since then he has served in every branch of the service and has become familiar with the wildlife problems throughout the North American continent. He went from field work in New England to the Mississippi Valley and the Great Plains states and was then transferred to the Pacific coast supervision of rodent and predatory animal control work in Washington, Oregon, California, Nevada and Idaho. As Regional Game Management Director for the states of the northwest he improved the organization and did valuable scientific work.

SCIENTIFIC NOTES AND NEWS

THE Nobel Prize in physics for 1935 has been awarded to James Chadwick, of the University of Liverpool, for his discovery of the neutron, made while working in the Cavendish Laboratory of the University of Cambridge. The prize in chemistry has been awarded to Professor Frederick Joliot and Mme. Irene Curie-Joliot for their synthesis of radioactive elements, working in the Curie Laboratory, Paris. It will be remembered that Mme. Curie-Joliot is the daughter of M. Pierre Curie and Mme. Marie Curie, who were awarded the Nobel Prize in physics in 1903 for the discovery of radium. Mme. Marie Curie also received the Nobel Prize in chemistry in 1911, for the isolation of radium.

THE University of Paris conferred *in absentia* on November 9 its honorary doctorate on Dr. Thomas Hunt Morgan, director of the William G. Kerckhoff Laboratories of the Biological Sciences at the California Institute of Technology.

THE Perkin Medal has been awarded to Dr. Warren K. Lewis, professor in chemical engineering at the Massachusetts Institute of Technology. The medal is awarded annually for valuable work in applied chemistry by a committee representing the five chemical societies of the United States. It will be presented to Dr. Lewis on January 10, at a meeting to be held at The Chemists' Club in New York City, when he will speak on "The Application of Physical Data to High-Pressure Processes."

THE Hughes Medal of the Royal Society, London, has been awarded to Dr. Clinton J. Davisson, research physicist on the staff of the Bell Telephone Labora-

tories, for his discovery, jointly with Dr. L. H. Germer, of electron diffraction. Recipients of the medal in the United States have included Dr. Alexander Graham Bell, Dr. O. W. Richardson, Dr. W. D. Coolidge and Dr. Irving Langmuir.

THE first award of the David Anderson-Berry Prize of the Royal Society of Edinburgh has been made to Dr. Charles Melville Scott, lecturer in materia medica at the University of Edinburgh, for his essay "On the Action of X- and Gamma-Rays on Living Cells." This prize, which consists of a gold medal and a sum of money, was founded by the late Dr. David Anderson-Berry in 1930, and is awarded triennially to the person, who, in the opinion of the council, has recently produced the best work on the nature of x-rays in their therapeutical effect on human diseases.

DR. A. P. COLEMAN, formerly professor of natural history and geology at Victoria University, and later professor of geology and dean of the faculty of arts at the University of Toronto, was presented with his portrait on November 18 at the Founders' Day observance of Victoria University.

A DINNER in honor of M. Albert Caquot, the French civil engineer, was given recently by the Franklin Institute, Philadelphia, under the auspices of the Franco-American Institute of Science and the Association Franco-Americaine. After the dinner he gave a lecture before the institute.

Nature reports that at the annual statutory meeting of the Royal Society of Edinburgh, held on October 28, the following officers were elected: *President,* Professor D'Arcy Wentworth Thompson; *Vice-presidents,* Professor C. G. Darwin, Professor R. A. Sampson, Principal O. Charnock Bradley, Professor P. T. Herring, the Marquis of Linlithgow and Professor E. B. Bailey; *General secretary,* Professor J. H. Ashworth; *Secretaries to ordinary meetings,* Professor F. A. E. Crew and Professor J. P. Kendall; *Treasurer,* Dr. James Watt.

DR. ARTUR HAAS, of the University of Vienna, is this year visiting professor of physics on the Tallman Foundation at Bowdoin College, Brunswick, Me. Dr. Haas is taking a lecture tour through the Middle West and to the West Coast during January. He will deliver the third Alexander Van Rensselaer Lecture at the Drexel Institute, Philadelphia, on December 4.

DR. RAOUL BLANCHARD has resigned as professor of geography at Harvard University. He holds a chair of the same name at the University of Grenoble, and since 1928, when he received a permanent appointment at Harvard, he has divided his time between the two institutions. In 1917 he was the French exchange professor at Harvard. His resignation will take effect at the end of the current calendar year.

DR. O. E. JENNINGS has been appointed head of the department of biology at the University of Pittsburgh, which has been formed by combining the existing departments of zoology and botany. All members of the former departments of zoology and botany are retained. Dr. Jennings has been connected with the university since 1911, since 1914 as head of the department of botany. He is also curator of the Carnegie Museum and director of the Lake Laboratory at Presque Isle since 1930. Dr. Robert T. Hance, since 1927 professor and head of the department of zoology, is now in charge of an enlarged program in the field of cytology.

THE following promotions have been made at the Stanford University School of Medicine: From associate professor to professor—James P. Baumberger, physiology; Maurice L. Tainter, pharmacology. From assistant professor to associate professor—Charles E. Clifton, bacteriology; John Field, II, and Victor E. Hall, physiology; John K. Lewis, medicine. From instructor to assistant professor—Charles W. Barnett, medicine; Edward Leef, medicine (radiology); James B. McNaught, pathology; Andrew B. Stockton, pharmacology.

H. H. WESTVELD has been appointed assistant professor of forestry in the department of horticulture of the College of Agriculture of the University of Missouri.

DR. MORRIS A. STEWART, instructor in biology at the Rice Institute, has resigned to join the department of entomology and parasitology of the College of Agriculture of the University of California at Davis.

DR. EDWARD HINDLE has been appointed regius professor of zoology in the University of Glasgow in place of Professor John Graham Kerr, resigned.

FRANK STUART ATKINSON, since 1925 manager of the Hatfield Main Colliery, has been appointed to the chair of mining at the University of Leeds, in succession to Professor J. A. S. Ritson, who has been appointed professor of mining at the Royal School of Mines, London.

DR. LEONARD HALFORD DUDLEY BUXTON, fellow of Exeter College, Oxford, has been appointed for a period of seven years reader in physical anthropology.

DR. THOMAS SHIRLEY HELE, university lecturer in biochemistry and fellow of Emmanuel, has been elected master of Emmanuel College, Cambridge.

VERNE E. CHATELAINE has become acting assistant director of the newly-established Branch of Historic Sites and Building of the National Park Service.

DR. EUGEN FISCHER has been appointed head of the Institute for the Biology of Heredity and Racial Hygiene, which was recently opened at Frankfurt-on-Main.

Nature reports that the following appointments have recently been made by the British Secretary of State for the Colonies: A. Pickles, entomologist, Department of Agriculture, Trinidad; J. W. Costello, late assistant conservator of forests, assistant conservator of forests, Nigeria; T. A. Strong, deputy conservator of forests, conservator of forests, Malaya, and J. G. Watson, conservator of forests, deputy director of forests, Malaya.

DR. W. H. MILLS, the Right Hon. Lord Riverdale, Professor A. Robertson and H. B. Shackleton have been appointed members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research of Great Britain, to succeed Dr. E. J. Butler, Sir Kenneth Lee and Professor N. V. Sidgwick, who have retired.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. Harry H. Sobotka, head of the department of chemistry at the Mount Sinai Hospital, New York, in aid of a "Chemical and Serological Study of the Enzymatic Destruction of the Blood-group Specific Carbohydrate."

DR. H. L. SHIRLEY, of the Lake States Forest Experiment Station, has recently been granted a fellowship under the Carl Schurz Memorial Foundation. Under this fellowship Dr. Shirley is making a study of forest tree seed germination practices and reforestation methods generally in Germany, Czechoslovakia, Poland, Switzerland and other Central European countries. He will be in Europe for several months.

DR. O. M. HELFF, associate professor of biology at New York University, has leave of absence for a year, during which he expects to work in the department of zoology of the University of Cambridge and in other European laboratories.

DR. LEO LOEB, professor of pathology at the Medical School of Washington University, St. Louis, delivered a Sigma Xi lecture at the University of Missouri on October 31. His subject was: "The Thyroid Stimulating Hormone of the Anterior Pituitary Gland."

THE eleventh annual Norman Lockyer Lecture, established by the British Science Guild as a means of periodically directing the attention of the public to the influence of science upon human progress, was given by Sir Josiah Stamp, president of the British Association for the Advancement of Science, on November 13. The subject of the lecture was "The Calculus of Plenty."

DR. BERNARD SMITH, who was recently elected director of the British Geological Survey and Geological Museum, delivered one of the Cantor Lectures of the Royal Society of Arts on November 18. He will deliver the second and third lectures on November 25 and December 2. The title of the lectures is "Geological Aspects of Underground Water Supplies."

THE annual meeting and dinner of the U. S. Institute for Textile Research was held in New York City on November 14. Dr. Robert A. Millikan, of the California Institute of Technology, and Dr. J. R. Katz, director of warp-sizing research of the institute, were the principal speakers. Among those present at the dinner were Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and Dr. Henry A. Barton, director of the American Institute of Physics. Dr. Francis P. Garvan, of the Chemical Foundation, was elected president.

THE Committee on Grants-in-Aid of the National Research Council will hold its next meeting in March, 1936. Applications for grants to be considered at this meeting must be on file with the secretary of the committee, Dr. Clarence J. West, not later than February 15. Application blanks will be furnished on request.

APPLICATIONS for associate and assistant metallurgist (recovery) and associate and assistant metallurgist (physical) must be on file with the U. S. Civil Service Commission, Washington, D. C., not later than December 9. The entrance salary for the associate grade is $3,200 a year, and for the assistant grade $2,600 a year. These salaries are subject to a deduction of 3½ per cent. toward a retirement annuity. Optional branches are: ferrous, nonferrous and ore dressing.

A FUND of $7,800 has been donated by the E. R. Squibb and Sons Company of New York City for the study of cyclopropane at the University of Wisconsin. The research program will be under the direction of Dr. Ralph M. Waters, professor of anesthesia in the Medical School at Madison.

THE 1935 award for chemical engineering achievement, to be presented by *Chemical and Metallurgical Engineering* at the close of the coming Fifteenth National Exposition of Chemical Industries, has been bestowed on E. I. du Pont de Nemours and Company for meritorious achievement in the successful large-scale production of synthetic rubber, synthetic camphor and a variety of other essential organic chemicals and dyestuffs. The award consists of an appropriate bronze plaque, suitably engraved to indicate the nature of the achievement and the name of the recipient. The first of these awards was won by the Carbide and Carbon Chemicals Corporation, and presented at the previous exposition.

FOR the past twenty-two years, the Brooklyn Botanic Garden and the Botanical Society of America have

cooperated in the production of *The American Journal of Botany*, in accordance with an agreement executed in 1913. The society had charge of the editing and the garden had charge of the business management and assumed certain financial responsibility. In harmony with a provision in this agreement, the Botanic Garden suggested to the society last June that the cooperation be terminated at the earliest convenience of the society. The society has now notified the Botanic Garden naming January 1, 1936 as the date for the termination of the agreement. After that date, the Brooklyn Botanic Garden will have no official connection with *The American Journal of Botany*.

AN expedition of nine men has left England to spend fourteen months in North-East Land. It is supported, according to the London *Times*, by Oxford University and the Royal Geographical Society, and will be under the leadership of A. R. Glen, leader of the 1933 expedition. The objects of the expedition are to map the unknown north and east coast of North-East Land, and also to explore the islands to the north and east. It is hoped to continue the survey of Victoria Island during the summer of 1936. Investigations on the ionosphere will be carried out, in continuation of the work of the British Polar Year Expedition, 1932–33, and research will also be made on cosmic rays, ozone and the *aurora borealis*. Two winter stations will be established on the western ice-sheet; each will be maintained by two men through the winter in order to examine the present balance of glacial conditions. The base hut is being built in Rijps Bay. The motor-ship Polar of Tromsö has been chartered to take the expedition to North-East Land, where no expedition has yet wintered.

DISCUSSION

POWER TO MOVE CONTINENTS

THE subject of continental drift seems to be still very much alive. This is evidenced by the fact that the International Astronomical Union[1] has been engaged in checking gross movements of earth crust since 1926 to determine the existence of systematic drift and by the very adequate discussion of the geological aspects of the case by Dr. W. W. Watts[2] in his presidential address before the British Association for the Advancement of Science in September, 1935.

It is notable that in all the discussion of the subject, the fact that "no plausible explanation of the mechanics involved has been offered" appears to be the final reason for not accepting the drift theory. This paper is an attempt to present a reasonable, understandable process of drift and is proposed for such consideration as it may deserve.

If continental drift occurred, if Malasia, Australia and Antarctica were moved from the Indian Ocean area, the problem is one of transportation; if the Americas were swung away from the Eurasia-Africa land body, transportation is again the central problem. The thing accomplished is a great engineering feat, done by recognized engineering methods. When inquiry is made regarding an adequate source of power to separate two continents by two thousand miles, the engineer answers without hesitation that only one such is conceivable—the heat engine.

What, then, are the geologically possible conditions under which a great natural heat engine may be created and so function as to separate continental masses?

The first requirement is that solid ocean bottoms shall not present an effective barrier to continental movement. This in turn demands a liquid substratum in the earth structure. Since the publication of Joly's[3] work on the geological effect of radioactivity the idea of a periodical liquid phase in a subsurface zone appears to be gaining favor. The engineer may then proceed on the basis that there are periods when the solid shell of rock is underlain by a liquid zone of like material. Moreover, that portion under the continental mass will be in a highly superheated condition; *i.e.*, dissolved gases will be exerting high pressure and the more volatile constituents of the complex liquid will be ready to vaporize with the slightest release of confining pressure. This condition of high temperature and high mobility with internally developed pressures is normally productive of dikes, sills and batholiths as well as lava flows, small and great.

Again, the fact that solid rock is heavier than its own melt is vital to the question. Ocean bottom, once broken into blocks, would sink and present no obstruction to the advancing continent. In fact, the advancing continent would act as an "ice breaker" and ride down the obstructions as encountered.

The stage is set for action by considering such an accumulation of temperature under the continental mass that bursting pressures occur and rupture takes place along a line following, of course, such lines of weakness as have been previously developed. A con-

[1] Science News note, SCIENCE, May 31, 1935.
[2] SCIENCE, September 6, 1935.
[3] "Radioacitvity and the Surface History of the Earth," Clarendon Press, 1924.

dition of gross movement is, of course, that the violence of eruption is sufficient to shatter adjacent ocean bottom.

Under these circumstances the line of fracture becomes a line of volcanic eruption and lava discharge, and this creates the side thrust necessary to separate the edges and widen the crack by floating the regions apart. Of course, such movement would occur only when the opposite continental edges can break up and ride down the opposing ocean bottom.

It is quite unnecessary to consider the thermodynamics of eruption, either of geyser or volcano, in detail. It is sufficient to recall that the action is that of a heat engine in which gas is produced by heat energy, expands on reduction of pressure on its upward movement, receives heat from its liquid surroundings, thereby approaching the isothermal, rather than the adiabatic process, and by its rapid rise through the liquid accelerates the latter to produce a spouting action.

This heat-pump action will actually produce a higher liquid level in the crack than exists on the opposite side of the continental block and will maintain such a differential head so long as the widening crack continues to uncover a fresh supply of superheated liquid.

Movement will cease when the material uncovered is so cool that it ceases to foam or when a portion of ocean bottom is encountered which holds its place.

On this view continental migration is an episode to be compared with a volcanic eruption or major lava flow. Its occasion is an unusual combination of accumulated thermal potential energy and worldwide catastrophe. That it has occurred not more than twice in two thousand million years entitles it to be classified as rare; we may not look for another continental scattering soon.

Though much time has elapsed since the Atlantic Ocean was formed, we still should be able to discern some evidence of such a world-shaking event. Three items of such corroborative support are offered: (1) The mid-Atlantic swell; (2) the Pacific foredeeps; (3) the Gulf of Mexico.

The crystalline rock material of the earth crust is brittle; very brittle, as any stone mason's hammer will show. Moreover, earth movements have shattered the most of it to bits at one time or another, as can be directly observed in the marble and granite of our great buildings. This clearly indicates that the fracture of a continent would be attended by vast crumbling. Of course, this crumbled material, being specifically lighter than the magma into which it tumbled, would form a swell or ridge in the Atlantic Ocean bottom following the general line of fracture. That there is such a swell in mid-Atlantic throughout its extent is corroborative evidence of the migration and of its episodal nature.

If the continental masses moved over the Pacific area, riding down blocks of ocean bottom, it might reasonably be expected that as the continental motion ceased, the down-going blocks would be caught and jammed in place forming deep holes in the ocean bed. The foredeeps of the Pacific constitute precisely such a system, as might be expected.

The central position of the mid-Atlantic swell indicates approximately equal masses of land in each of the traveling continents or an earlier stoppage of the American side. The general absence of foredeeps off the American shore indicates the former, while the Gulf of Mexico and the Easter Divide points to a collision stoppage of the American fragment.

Any one who accepts as reasonable the hypothesis of rapid continental migration here presented will recognize that the frail isthmus structure connecting the two Americas could never have withstood the hazards of so turbulent a voyage. Clearly the notch formed by the Gulf of Mexico and the Caribbean Sea was made after the crossing. The most plausible view of such a happening is that the central part of the American continent encountered an ocean bottom (the Easter Divide) which did not yield and that the inertia of the ends was sufficient to "break its back."

The fragments produced by such an impact would move about with much randomness in the boiling magma but would have a general tendency eastward with the current. Meanwhile the original angles of the two Americas would be changed and probably their north-south relation as well. In short, in a breakup of such magnitude and complexity anything could happen.

In discussing the subject there has been no intention of evaluating the evidence regarding continental migration: only to show that there is an adequate source of power whereby, under certain conditions, it might be accomplished.

However, in reading such discussions of the subject as have come to hand, it has been noted that the argument for continental migration which appears the most valid and convincing to the writer has never been mentioned. Briefly, it is that when nature assembles material, the resulting natural form is round or oval. This is true from spiral nebula to snowflake; from a swarm of bees to a colony of bacteria; from star to dewdrop. So we should naturally expect that when the lighter sial was separated from the heavier basic magma, whatever the process, the result would be an oval mass and that fragmentation into present land forms has been the result of later, disruptive processes.

If, as seems probable, the process was one of fractional distillation, followed by selective condensation

and selective solidification, the anticyclonic wind action would certainly give a radial distribution of material with considerable uniformity. A similar case is the radial distribution of snow to form the ice barrier which smooths the ragged edges of the Antarctic Continent. Here a new type of rock (ice) is formed and deposited through thermal, chemical and mechanical processes somewhat like those which probably acted to produce the original continental structure.

GEORGE W. MUNRO

PURDUE UNIVERSITY

PROTECTION FROM MOSQUITO BITES IN OUTDOOR GATHERINGS[1]

THE adult female mosquito has been the pest of mankind since time immemorial. In areas where mosquito eradication is not conducted at all or only to a limited extent, prodigious numbers of mosquitoes on the wing offer a great menace to our health and comfort, making it practically impossible to spend a summer evening outdoors without being badly bitten up. Some individuals are so highly susceptible to the after effects following these bites, which usually cause irritation and swelling, that they are afraid to leave their houses, screened porches and similar protected enclosures in the evenings. While the mosquito annoyance is especially unbearable in farm communities and suburban districts, towns and cities are by no means free from it.

The problem of temporarily ridding a small area of adult mosquitoes where a large number of people could comfortably enjoy a summer evening has often presented itself. Such places may vary in area from a few square yards to several acres and may consist of a well-cared-for lawn, shrubs, flowers, trees and other valuable vegetation which must not be injured. It is obvious that in order to eliminate mosquitoes the area must be treated in such a way that those on the wing or resting in the grass within the area are killed or incapacitated, while those outside of the treated area are repelled.

The New Jersey mosquito larvacide[2] contains a light petroleum oil and pyrethrum and has been extensively applied during the last three years in exterminating larvae and pupae in waters without injury to fish, water-fowl and vegetation. Pyrethrum was shown to be toxic[3, 4] as well as repellent[4] to adult mosquitoes. Furthermore, it had been observed by many mosquito workers that the female mosquito will not lay eggs on water covered with kerosene or fuel oil. Evidently light petroleum oil also possesses repellency against the adult mosquito. In view of the above properties it was conjectured that the larvacide, applied as a diluted spray over the entire area where the meeting takes place, might prove effective and economical for temporary protection.

Accordingly experiments were conducted with various dilutions of this larvacide. Up to date the writer has records of some 50 tests on areas ranging from a few square yards to 5 acres, involving evening gatherings of from 10 to 2,000 people. The results indicate that it is quite possible and economical partially or completely to protect an outdoor gathering such as carnivals, picnics, open-air theaters, lawn parties, etc., from mosquito annoyance by spraying the area with the larvacide diluted 1:10 or 1:12 with water without any appreciable injury to vegetation and without discomfort to the audience. The spray is applied in the form of a fine fog, covering the grass, ground, shrubs, as well as throughout the air.

DIRECTIONS FOR SPRAYING

About half an hour before the gathering takes place the area is completely sprayed with the larvacide diluted 1:10 or 1:12, that is 1 part of larvacide is mixed with 10 or 12 parts of water. The spraying is done with a power sprayer capable of developing a pressure of 100 pounds or more per square inch and equipped with a spray gun. Before mixing with water the concentrated stock larvacide should be well shaken. Also the diluted spray should be frequently stirred or agitated in order to secure uniform distribution throughout the spraying operation. The spray is applied in the form of a fine fog directly to the grass, grounds, tents, trees, shrubs, etc. Then the stream is directed upward so as to saturate the atmosphere with the fog. At no time should a coarse spray be applied, since it is unnecessary and may injure vegetation. The grounds for about 20 feet outside the area should also be thoroughly fogged, especially when tall grass, shrubs, woodland and other vegetation are present offering a hiding place from which adult female mosquitoes may issue suddenly at dusk in large numbers. If the area has been thoroughly fogged one treatment may suffice for two hours or even the rest of the evening. If mosquitoes become bothersome later in the evening, the area on the outside of the "gathering" grounds should again be fogged, directing the stream primarily upward and towards the ground to be protected. This outside fogging may be repeated again if necessary. On small areas, such as back-yards, private lawns, etc., a knapsack sprayer or bucket pump capable of producing a fog spray, of 10 to 15 feet high, can be used.

[1] Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

[2] J. M. Ginsburg, *Proc., 17th Annual Meeting N. J. Mosq. Ext. Assoc.*, p. 57, 1930.

[3] J. M. Ginsburg, *Proc. 21st Annual Meeting N. J. Mosq. Ext. Assoc.*, p. 21, 1934.

[4] J. M. Ginsburg, *Proc. 22nd Annual Meeting N. J. Mosq. Ext. Assoc.*, 1935.

In one experiment a five-acre fair ground surrounded with shrubs and woodland was sprayed five evenings in succession. On the night before spraying was started the mosquitoes were so numerous and vicious that many people were forced to leave the grounds about 9 P. M. During the succeeding evenings, when the larvacide was applied, discomfort from mosquitoes was insignificant and the audience was well pleased. Subsequent observations have disclosed practically no injury to the shrubs and trees and only slight burning to the grass blades.

Thus far the larvacide was found effective against the following species of mosquitoes: *Culex pipiens, Aedes vexans, Aedes sollicitans* and *Mansonia perturbans*. Tests will be conducted against other species whenever available.

The formula of the present New Jersey mosquito larvacide, which has been recently improved[5] to be compatible with hard and salt water, is as follows:

FORMULA FOR TANK PREPARATION

100 gallons kerosene containing pyrethrum extract equivalent to one pound of flowers (analyzing 0.9 per cent. pyrethrins) per gallon.
50 gallons water.
6 pounds sodium laurel sulfate (emulsifier).

The emulsifier is first mixed with the water and transferred to the tank. The oil is then run in gradually into the tank with agitators and pump working at full speed. After all the oil has been added the pumping is continued until the entire mixture has passed through the hose and back into the tank two or three times or until the mixture is thick and homogeneous, showing no free oil on the surface. The finished product is then pumped into drums for storing. This constitutes the stock emulsion. Excessive foaming may be eliminated by dissolving about two or three pounds of wool grease (Degras) in the kerosene before emulsifying. Any other suitable apparatus for emulsification can be used.

The cost of preparing the concentrated emulsion is about 23 cents per gallon, based on the present price of pyrethrum, which makes out slightly over 2 cents per spray gallon. When purchased, the stock emulsion costs from 30 to 50 cents per gallon, depending on the quantity ordered.

While this larvacide, when prepared and applied as directed, is apparently safe on vegetation, as brought out by the results thus far reported, further experiments are at present conducted in order to verify the above findings under all kinds of conditions and on many varieties of plants.

JOSEPH M. GINSBURG

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[5] W. Rudolfs, *N. J. Agr. Expt. Station Bulletin 496*, 1930.

ORIGIN OF THE GENUS NAME RIBES

THE Latin name at present used for the common cultivated red currant is *Ribes sativum*. The genus name Ribes, for which one does not find in any of our dictionaries a derivation both adequate and correct, is derived from the Arabic through a curious chain of circumstances.

From very early times the Arabs have held in high repute a medicine prepared from a species of rhubarb native in the mountains surrounding the Arabian desert and cultivated in Arabian gardens. The Arabic name of the plant was rībās. The young stems and young leafstalks were crushed and the juice was extracted by pressure and made into a syrup by boiling slowly with an equal weight of sugar. This acidulous syrup was an article of commerce among the Arabs and its use by them was wide-spread.

I should like to be able to say that, after their conquest of Spain in the eighth century, the Arabs, not finding in western Europe the plant from which their favorite syrup of rhubarb was made, but finding another plant, the red currant, from which a similar syrup was prepared, gave to the new plant the Arabic name ribas, transferred from the much-beloved rhubarb native in their own country. I have no means to make certain, however, whether the name ribas reached western Europe from Arabia by this romantic route or whether it traveled overland, north of the Mediterranean, by some non-Arabic road. It seems clear, however, that it was from the similarity of the two syrups that the Arabic name came to be applied by early European botanical writers to their native red currants, in the Latinized form ribes. The Arabic name of the rhubarb syrup was rubb rībās or robb rībās (pronounced rahb reebahs), the Arabic word rubb standing for syrup and ribas for rhubarb. When this name was transferred to western Europe and applied by apothecaries to the syrup made from red currants, it took the form rob ribes, or the form preferable in Latin, rob ribis, ribis being the genitive of ribes, the expression meaning, literally, syrup of ribes. Then, having misappropriated the name rob ribis, doubtless unconsciously, for their own native syrup, the west-European apothecaries gave to the genuine and original product of Arabia the name rob ribis Arabum, syrup of ribes of the Arabs. A very neat and exact summary of facts about the Arabian rhubarb is contained in its descriptive designation by Desfontaines, paraphrased from the part-Latin, part-German; description by Rauwolf in 1583, "ribes Arabum, ex quo rob ribis conficiunt," ribes of the Arabs, from which they make their syrup of ribes.

When Linnaeus, coming after the early European botanical writers, published his "Species Plantarum," in 1753, he gave to the rhubarbs the genus name

Rheum, and to this Arabian rhubarb the species name *Rheum ribes,* in recognition of its ancient Arabic name, and to the currants he gave the genus name Ribes.

An excellent account of *Rheum ribes* was published by Desfontaines in 1803 in Annales du Museum National d'Histoire Naturelle (volume 2, pages 261 to 268, plate 49) and a well-executed colored illustration is given in Curtis, *Botanical Magazine,* 1898, plate 7591.

FREDERICK V. COVILLE
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FAULTING IN THE MOHAWK VALLEY

THE age and origin of the extensive faulting along the southern edge of the Adirondacks in the Mohawk Valley has long been a problem to investigators. It was with the object of obtaining information which might lead to a solution of this problem that the writer spent portions of the summers of 1930 and 1931 in geologic investigation of this area.

The displacements are high-angle normal faults trending generally north northeast—south southwest and cutting pre-Cambrian and lower Paleozoic formations. Most of the faults are upthrown on the western side with the amount of displacement increasing to the northward toward the Adirondacks, but dying out rapidly a few miles south of the Mohawk River.

Since the faults are high-angle (over 80°) with the hanging wall invariably downthrown, they imply tensional stresses and hence are to be correlated with periods of relaxation which usually follow the compressive phases of mountain deformations. That the faults are younger than the Taconic folding is evidenced by their displacing of not merely the Schenectady beds, which are believed to have been deposited during the compressive phase of this deformation, but of the even younger Utica shale. The fact that the faults die out to the south argues for a primary relationship to the Adirondack region. In addition, their proximity to areas to the east which show distinct folding and thrusting as a result of the Taconic revolution bears out the conclusion that the tensional stresses of the period of relaxation following this deformation were responsible for the initiation of this faulting.

During the Taconic disturbance, the forces of compression in the sedimentary troughs were relieved by folding and thrusting. In the much more resistant pre-Cambrian rocks of the Adirondacks, however, these stresses were resolved so that the eastern part of the massif was uplifted rather than folded and thrust-faulted. The greatest uplift very likely took place northward from the Mohawk Valley and away from the area of thicker sediments. After the Taconic compression had ceased, relaxational movements began, and the east and south sides of the Adirondack area were cut up by normal faults. Most relaxation occurred where the preceding compression had caused greatest uplift, and consequently the throws of these faults increase to the north. Subsequent revolutions may well have caused additional adjustments along these faults.

More than twenty-five of these faults have been mapped in detail, and it is expected that further information regarding them will be published in the near future.

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NORTH AMERICAN FISH-HOOKS

AN ethnographical survey of fish-hooks in North America made by the present writer raises an important question as to the origin of barbed hooks. Until now it has been conjectured that such hooks were introduced among the American natives by European traders.

In different museum collections there are several barbed hooks from the Aleutian Islands and from California, which are of undoubted antiquity. Those from the northwest coast are regularly barbed, whereas the Californian specimens are barbed on the outside.

From a study of these hooks I have come to the conclusion that barbs on fish-hooks might have been an aboriginal invention and that the possible line of distribution was that after the introduction into Alaska from Asia, a branching out in two directions took place—one towards the northeast, extending across the Canadian arctic shores as far as Greenland, and the other almost directly south over Yukon, British Columbia and Washington to Southern California. This is also in accordance with what we know of the migration of the peoples in the North American continent.

This possibility has so far been neglected, and it seems to me that ethnographers and archeologists in the field would do well to bear this in mind.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MINUTES OF THE EXECUTIVE COMMITTEE

THE fall meeting of the executive committee was held in Washington, D. C., on October 27, 1935, at the Cosmos Club, with the following members present: Drs. Cattell, Caldwell, Compton, Conklin, Curtiss, Livingston, McKinley, Ward, Wilson and Woods.

The minutes of the last meeting held in Minneapolis in June were reported as having been approved by mail and published in SCIENCE.

It was voted that a committee on membership be appointed to canvass the possibilities of increasing the membership in the association, in cooperation with the permanent secretary's office. It was further voted that the problem of increasing membership in the association be added to the agenda of the Secretaries' Conference at Saint Louis and the committee was instructed to send a preliminary report to each member of the conference before the meeting. The chairman appointed Drs. Livingston (*chairman*), Caldwell, McKinley, Woods and the permanent secretary as members of the Committee on Membership.

The financial reports of the treasurer and the permanent secretary for the fiscal year 1935 were presented, accepted and ordered audited. The treasurer's budget for the fiscal year 1936 was approved as presented.

The budget of the permanent secretary for 1936 was approved with minor adjustments. The budget submitted by the director of exhibits for the Saint Louis exhibition was approved as presented.

The general secretary reported (1) on activities of local branches, (2) on relations with the affiliated state academies, and (3) outlining plans for the Secretaries' Conference at Saint Louis.

It was voted that the membership of the Academy Conference consist of the representatives of the affiliated academies in the council of the association and the members of the executive committee of the association.

A preliminary list of important events in the program of the Saint Louis meeting was presented by the permanent secretary and discussed.

The permanent secretary presented for discussion and action data on future meetings and a list of meeting places which had been either officially or tentatively fixed. He was authorized to publish the list of meeting places, through 1940, as follows:

St. Louis, Missouri: December 30, 1935, to January 4, 1936.
Rochester, New York: June 16 to June 18, 1936; Ithaca: June 19 and June 20.
Washington, D. C.: December 28, 1936, to January 2, 1937.
Denver, Colorado: June, 1937. Joint meeting with Southwestern and Pacific Divisions.
Indianapolis, Indiana: December 27, 1937, to January 1, 1938.
Summer, 1938: Eastern Canada or New England (in June).
Winter, 1938: Richmond, Virginia, December 26 to December 31.
Summer, 1939: Milwaukee, Wisconsin (in June).
Winter, 1939: Columbus, Ohio, December 26 to December 31.
Summer, 1940: Joint meeting with Pacific Division. In Pacific Coast Territory in June.
Winter, 1940: New York City.

The report of the Committee on Exhibits concerning proposed arrangements for the exhibition at Washington in 1936 was approved.

The selection of general hotel headquarters for the Washington meeting was placed in the permanent secretary's hands with power.

The executive committee approved the plan to provide membership in the association for selected agencies in Latin American countries.

The executive committee considered various applications for grants to aid in publishing reports and for printing funds, but with expressed regret voted that under present conditions no funds were available for those purposes.

After some discussion the executive committee approved the organization of subsections under the following designations:

Section of Medical Sciences (N): Subsection on Dentistry; Subsection on Pharmacy.
Section on Engineering (M): Subsection on Aeronautics.

Upon invitation from the American Academy of Tropical Medicine, Drs. McKinley and Ward were named representatives of the association at the meeting of the academy to be held in Saint Louis on November 20, 1935.

Professor R. M. Ogden, Cornell University, was elected chairman of the Section on Psychology to fill the vacancy caused by the death of Dr. Joseph Peterson.

The committee approved the appointment of Professor Charles J. Tilden as a member of the executive committee of the Section on Engineering, to succeed Calvin W. Rice, deceased.

Dr. Edgar Allen, Yale University, was elected a member of the section committee of the Section on Medical Sciences to succeed Dr. George H. Bigelow, deceased, term to expire at the end of 1936.

The permanent secretary presented reports from section secretaries on balloting for section officers for 1936; final action was postponed until the first meeting of the executive committee at Saint Louis.

It was voted to adopt the following rule regarding acceptability of papers offered for the programs of meetings.

Resolved: (1) That papers presented on the programs of the American Association for the Advancement of Science should not refer to commercial trade names of products where this can be avoided, in order to eliminate the criticism which might be made that such reference in scientific papers is in any way associated with advertising.

(2) That papers for the programs be accepted with the understanding that full scientific information is available for presentation and discussion if pertinent to the specific phase of the research being reported or described.

It was voted that nominations for emeritus life memberships under the Jane M. Smith fund be referred to the Committee on Emeritus Life Memberships, with power.

The report of the Committee on Source Books in the History of Science was read and accepted. The general secretary presented a progress report (1) of the Committee on Radio Program at Saint Louis and (2) on the activities of the Committee on the Place of Science in Education. After considerable discussion on the field and the work of the Committee on Adult Education, the report from the committee was accepted.

The Limnological Society of America was accepted as an *affiliated* society. (The society has a total membership of 238 members. Of this number 170 are members of the association, 82 of these being fellows. The society is entitled to one representative in the council of the association.)

The Alpha Chi Sigma Fraternity was accepted as an *associated* society. (This society has a total membership of 10,583. Of this number 1,232 are members of the association, 568 of these being fellows.)

The Chi Beta Phi Scientific Association was accepted as an *associated* society. (This society has a total membership of 1,449. Of this number 36 are members of the association, 31 of these being fellows.)

The permanent secretary reported for record the appointment of Dr. H. S. Jennings as representative of the association to the meeting of the British Association for the Advancement of Science, held in Norwich, September 4–11, 1935.

The permanent secretary reported for record the appointment of Dr. J. McKeen Cattell and Professor M. S. Vallarta, Massachusetts Institute of Technology, as representatives of the association to the seventh American Scientific Congress held in Mexico City, September 8–17, 1935.

The chairman of the executive committee and the general secretary were appointed a committee to consider the possible relations of the association with scientific organizations and workers in science in Mexico, and to present at a later meeting such recommendations as they feel should be made.

Dr. H. G. Moulton was elected a fellow of the association.

It was voted that the spring meeting of the executive committee in 1936 be held in Lancaster, Pa.

The permanent secretary presented a progress report on the organization of a Southeastern Division.

The permanent secretary reported for record the receipt of the annual report of the Joseph A. Holmes Safety Association.

The following resolutions from the American Pharmaceutical Association were read and placed on record:

Resolved, That the American Pharmaceutical Association desires to express its gratification to the American Association for the Advancement of Science for the creation of a Section on Pharmacy and for the opportunity to present a separate program illustrating the contributions of pharmacy to the advancement of science.

Resolved, That the American Pharmaceutical Association appoint two delegates to the Seventh American Scientific Congress to be held in Mexico City from the 8th to the 17th of September of this year and that those delegates be instructed to participate as fully as possible in all the efforts to make the Congress a success.

Two resolutions were presented from the Ecological Society of America on (1) preservation of natural areas and (2) program of the Quetico-Superior Council. The committee expressed its general approval and indicated that the substance of these resolutions was contained in resolutions previously adopted by the council.

The meeting adjourned, to meet at the Jefferson Hotel in Saint Louis.

HENRY B. WARD,
Permanent Secretary

SPECIAL ARTICLES

FURTHER EVIDENCE FOR THE PRESENCE OF A TOXIC FACTOR IN PERNICIOUS ANEMIA[1]

VERY recently, Mermod and Dock[2] reported their confirmation of Massa and Zolezzi's[3] finding that the intravenous injection of repeated doses of the dye, Congo Red, produces effects similar to those of liver

[1] From the department of physiology and pharmacology, University of Louisville School of Medicine. This investigation has been made with the assistance of a grant from the Committee on Therapeutic Research, Council on Pharmacy and Chemistry, American Medical Association.

[2] C. Mermod and W. Dock, SCIENCE, 82: 155, 1935.

[3] M. Massa and G. Zolezzi, *Klin. Wochnschr.*, 14: 235, 1935.

extract in patients with pernicious anemia. Mermod and Dock point out that this observation, together with the known effectiveness of Congo Red in neutralizing certain toxic substances, calls for a further exploration of the old theory that pernicious anemia is due to the presence of some toxic agent. During the past two years we have accumulated a certain amount of evidence for the presence of a toxic factor in pernicious anemia.

Sterile morning urine specimens obtained from eight untreated pernicious anemia patients (two males and six females) were injected intramuscularly into pigeons. Eight pigeons were used for each urine. Four of the birds received 0.1, 0.5, 1.0 and 1.5 cc of urine per 100 gm of pigeon respectively for five successive days. The other four pigeons were given corresponding amounts of urine previously heated to 100° C. for two hours. Daily reticulocyte counts were made for two weeks prior and for six weeks subsequent to the first injection. Each of the eight unheated urines produced a decrease in the reticulocytes of the pigeon below the significant level of 5 per cent. (Repeated daily counts on more than one hundred fifty control pigeons by a method already reported[4,5] have never shown a minimum reticulocyte percentage of less than 5.) The significant minimal counts varied from 0 to 4 per cent. with an average of 2 per cent. The peaks of the decreases were obtained on the 5th to the 8th days. The reticulocyte decreasing substance is thermolabile, inasmuch as none of the pigeons injected with the heat-treated urines showed a reduction in reticulocytes. Likewise, pigeons receiving corresponding doses of six normal human urines, unheated and heated, failed to show a reticulocyte decrease. The four urines containing the greater concentrations of the reticulocyte decreasing principle were definitely toxic, since 15 of the 21 birds injected with these urines died in from one to eight days following the first injection. Indeed one urine was so toxic that smaller doses (.025 and .05 cc) were necessary in order to demonstrate the reticulocyte decreasing effect. On the other hand, of the 32 pigeons injected with the heat-treated pernicious anemia urines which were without reticulocyte decreasing effect, all but one survived. Likewise the 48 pigeons receiving the normal unheated and heated human urines survived. The toxicity, therefore, is associated with the reticulocyte decreasing factor and is very probably due to it.

Following the primary decrease in reticulocytes, most of the surviving pigeons showed a subsequent reticulocytosis. This reticulocyte stimulating effect was partially retained by the heat-treated pernicious anemia urines. A detailed consideration of the significance of this reticulocyte stimulating substance previously reported to be present in normal human urine[4,5] is outside the scope of this progress note. However, the possibility of the identity or similarity of this second urinary substance and the anti-pernicious anemia principle is suggested by the reports of Decastello[6] and one of us.[7] Obviously more work is necessary, although these findings also throw doubt on the current deficiency theory as a complete explanation of the pathogenesis of pernicious anemia.

Thus far, we have examined the urines of two treated pernicious anemia patients and have found the toxic, reticulocyte decreasing substance absent. Interestingly enough, the concentration of the reticulocyte stimulating principle in these two urines was definitely decreased.

It is apparent, therefore, that urine from untreated patients with pernicious anemia contains both a thermolabile, comparatively toxic, reticulocyte decreasing factor and a partially thermostable, relatively nontoxic, reticulocyte stimulating principle for the pigeon. Normal human urine contains the latter but not the former, or at least not in the quantities of urine used. What relation the urinary reticulocyte decreasing principle bears to the toxic substances reported by Macht,[8] Mermod and Dock,[9] and Kingisepp[10] as present in the plasma of untreated pernicious anemia patients is largely speculative at present. If our impression that the principle acts through depressing erythrogenesis in the bone-marrow should prove to be correct, the production of experimental pernicious anemia in mammals by the separation and administration of sufficient quantities of the reticulocyte decreasing factor is not beyond the realm of possibility.

G. E. WAKERLIN
H. D. BRUNER

SOME OBSERVATIONS ON ULTRA-VIOLET IRRADIATED AMEBAS

PRELIMINARY to a study of the manner in which various saline solutions modify the action of ultra-violet light on protoplasm a number of exploratory experiments were done upon *Amoeba proteus*. In the course of these experiments certain results of more general interest were obtained.

(1) Changes in the prominent food vacuoles of approximately 15 amebas were observed during and

[4] G. E. Wakerlin, H. D. Bruner and J. M. Kinsman, *Proc. Am. Physiol. Soc.*, p. 136, 1935.
[5] G. E. Wakerlin and H. D. Bruner, *Arch. Int. Med.*, in press.
[6] A. Decastello, *Med. Klin.*, 31: 377, 1935.
[7] G. E. Wakerlin, *Proc. Soc. Exp. Biol. and Med.*, 32: 1607, 1935.
[8] D. I. Macht, *Jour. American Medical Association*, 89: 753, 1927.
[9] C. Mermod and W. Dock, *Proc. Soc. Exp. Biol. and Med.*, 32: 373, 1934.
[10] G. Kingisepp, *Klin. Wochnschr.*, 13: 1820, 1934.

following irradiation. In most cases a "Cold Quartz" lamp was used with which 10 irradiations each of approximately 10 seconds duration were given at 10-minute intervals. Most of the light of this lamp is of wave-lengths ranging from 2540Å to about 1800Å. A few were observed under irradiation from a Kromayer quartz mercury arc, which gives relatively much more energy at longer wave-lengths, including an appreciable amount of heat and visible light. These radiations were of such intensity that morphological changes, as described by Black,[1] were noticeable after about 30 seconds exposure. Digestion seemed to stop with the first appearance of these morphological changes and did not resume during the remaining life of the now moribund amebas. Ultimate death, with cytolysis, was often delayed for from 12 to 24 hours after irradiation. Upon disintegration of the amebas the food particles could be seen apparently in the same condition as when they were examined before the commencement of irradiation. This suggests that irradiation inactivated the digestive enzymes or stopped their secretion or elaboration. It might also be supposed that proenzymes or the coenzymes necessary for their activation were affected. It is well known that ultra-violet light inactivates many enzymes and similar substances *in vitro*. Induced impermeability of the walls of the food vacuole must also be considered in seeking an explanation of the stoppage of digestion.

(2) Five amebas were exposed to an oblique beam of ultra-violet light from a Kromayer lamp. They all oriented and moved away from the source. The angle of incidence of the ultra-violet light was made as nearly parallel as possible to the surface upon which the amebas were moving. Although the radiation included a good deal of visible light, this was not great relative to the bright diffuse daylight which was not oriented. The response, therefore, appears to have been evoked by ultra-violet light. It is hardly possible on the basis of the available evidence to say whether it may be a direct effect upon the contractile mechanism; such as increased viscosity or gelatin of the sol in the more intensely illuminated side before the plasmagel is broken down.

There are several reports of modifications of the degree of motility or the direction of movement of amebas as a result of irradiation by visible light, but ultra-violet light appears not to have been studied with regard to tropism.

Harrington and Leaming[2] found that intense white or violet light thrown on an active *Amoeba proteus* produced instantaneous stoppage of protoplasmic streaming. This observation was confirmed by Mast[3] and Folger.[4] Mast found that a sudden increase in light intensity caused all streaming to stop and that the effect was repeated as one passed from one wave-length to a shorter one, while no effect was obtained when the wave-length was changed in the reverse direction. Visible light was used throughout.

Davenport,[5] using white light, found negative phototropism in *Amoeba proteus*. Mast[3] confirmed this and observed that the process of orientation is associated with inhibition of pseudopod formation on the more highly illuminated side. Mast[6] says that *A. proteus* orients negatively in directive illumination in strong light but probably positively in very weak light.

(3) The surface membranes of amebas are often regarded as extensible,[7] but there appear to have been no quantitative measurements of this extensibility or elasticity. We found that after amebas had been made to round up by the action of ultra-violet light the membrane appeared relatively inextensible. Many camera lucida drawings of outlines of the amebas were made, and they indicate that the increase in diameter can not have been greater than of the order of 10μ for an ameba 150μ in diameter. This represents an increase in surface of less than 14 per cent.

It is quite possible that ultra-violet light leads to increased internal pressure, and this in turn to increase in volume and attendant rounding up of the amebas. At first the volume may increase simply by approach to a spherical form without greatly stretching the membrane, but further swelling thereafter must stretch it, and unless it is extensible further irradiation must ultimately rupture it with little or no expansion. The ultimate cytolysis of irradiated cells often has the appearance of rupture of the membrane as a result of internal pressure.

It seems necessary to conclude that the surface membranes of irradiated amebas are relatively inextensible. Whether this conclusion may be generalized to include unirradiated amebas is doubtful. The extensibility of the cell membrane of an irradiated ameba may be very different from that before irradiation, probably much less.

SUMMARY

(1) Observations upon irradiated amebas indicate that digestion of food is stopped by ultra-violet light

[1] W. A. Black, "Experimental Modifications of the Effect of Ultra-violet Light on Protoplasm.—I. *Amoeba proteus.*" In process of publication.

[2] N. R. Harrington and E. Leaming, *Amer. Jour. Physiol.*, 3: 9–18, 1900.

[3] S. O. Mast, *Jour. Exp. Zool.*, 9: 265–277, 1910.

[4] H. T. Folger, *Anat. Rec.*, 29: 96–97, 1924.

[5] C. B. Davenport, "Experimental Morphology," 280 pp., London and New York, 1897.

[6] S. O. Mast, *Zeitschr. vergl. Physiol.*, 15: 139–147, 1931.

[7] J. G. Edwards, *Brit. Jour. Exp. Biol.*, 1: 571–596, 1924.

and that cessation occurs with the appearance of morphological symptoms of impairment.

(2) *Amoeba proteus* shows negative phototropism toward ultra-violet light.

(3) The cell membrane of irradiated amebas is relatively inextensible.

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A CONTRIBUTION TO THE PHARMACOLOGY OF PHYSOSTIGMINE[1]

WHILE investigating the peripheral action of barbiturates, we observed that in all experimental animals where the cardiac vagus response to weak faradic stimulation had been abolished by barbiturates doses of physostigmine salicylate ranging from 0.2 to 0.35 mgm per kgm showed no detectable spontaneous effect on the heart rate. However, if two to three minutes were allowed to elapse after intravenous administration of this drug and then the peripheral vagus was stimulated with the same weak, or even weaker, faradic current as used above profound cardiac inhibition was produced. Occasionally the slowing of the heart which was produced by stimulation of the peripheral vagus persisted for several minutes after stimulation was discontinued. A similar cardiac slowing was noted following injection of acetyl choline, but it was not as marked and consistent.

This physostigmine sensitization of the vagus to stimulation lasted for about 30 minutes and was promptly antagonized by intravenous injections of further doses of barbiturates.

On the assumption that barbiturates produced their vagus-impairing effects by ganglionic depression, we employed in another series of experiments nicotine salicylate in doses varying from 2 to 4 mgm per kgm to produce ganglionic paralysis in dogs and rabbits. After sufficient nicotine salicylate had been administered intravenously to render the peripheral vagus non-responsive to even strong faradic stimulation, physostigmine (0.2 to 0.3 mgm per kgm) was injected intravenously. In every case within three minutes following the injection of physostigmine, faradic stimulation of the peripheral end of the vagus nerve produced marked cardiac inhibition. In other words, physostigmine antagonized the synaptic paralysis produced by nicotine.

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JAMES M. DILLE
THEODORE KOPPANYI

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PROPOSED METHOD FOR THE DIRECT MEASUREMENT OF CORRELATION

ATTENTION is called to the possibility of applying certain relations given by Yule to the development of a device for the physical determination of the correlation coefficient. The relations are:

$$\Sigma_1^2 + \Sigma_2^2 = \sigma_1^2 + \sigma_2^2$$

$$r^2 = 1 - \frac{\Sigma_1^2\,\Sigma_2^2}{\sigma_1^2\,\sigma_2^2}$$

where Σ_1 and Σ_2 are the maximum and minimum standard deviations of the scatter about the intersection of mean$_1$ and mean$_2$, and σ_1 and σ_2 have the usual connotations.[1]

Given the correlation surface actually constructed, the measurement of all these standard deviations in terms of moments should be feasible. The equivalence of σ^2 to the moment of inertia of the distribution about its mean is well known. It is possible that a physical method has not yet been applied to correlation because of the difficulty of obtaining cross-products. If Yule's Σ_1^2 and Σ_2^2 can be physically measured, this difficulty is eliminated by the proposed method.

A moment of inertia is measurable as $\frac{T\,t^2}{2\,\theta}$, where T is torque applied (constant), and t is time to reach θ, which is resultant angular displacement. What would seem necessary then would be a device utilizing unit rotational force acting through unit time, whence a moment would be found in terms of distance rotated. A spark marker could be used to measure this distance. Having found the means of the constructed correlation surface by balancing, σ_1^2 would be obtained by rotation of the surface about the line through mean$_1$ parallel to the axis of the other variable, and correspondingly for σ_2^2. The axes of rotation for finding Σ_1^2 and Σ_2^2 would be passed diagonally through the intersection of mean$_1$ and mean$_2$ (center of gravity). The angles of these axes would be varied until the minimum or maximum rotation had been noted. Inspection of the surface would reveal the angles for these axes closely for correlations higher than .30.

For plotting the scatters there could be provided light, rigid trays having twenty cells each way and a small post in each cell. With thin but heavy metal coins having holes in the centers, the plotter could construct the surface as rapidly as one plots the usual scatter on paper. The coins should fit snugly and be thin enough to give the surface a relatively small vertical dimension. The physical measurements of the

[1] From the Department of Pharmacology and Materia Medica, Georgetown University, School of Medicine, Washington, D. C.

[1] "Introduction to the Theory of Statistics," p. 322, 1919.

surface could then be taken, applying forces which would cause rotations through acute angles only.

For recording the scatter plots before removing the coins, a device could be arranged to fit over the tray in such a way as to register automatically the number of coins in each cell. For researches in which the scatters are needed, something will have been gained in a standard machine method of recording scatters. When not needed, little will have been lost in making the scatters, because plotting often requires little more time than does organizing the material for use in other correlation methods.

In so far as the tray's weight would be uniform, correction of the moments for this factor should be possible as part of the calibration of the machine. Coefficients higher than .90 might require special attention because, while their smaller probable errors would require the greater precision, their Σ^2_{min}'s would be small and probably difficult to measure. With $\sigma_1 = \sigma_2 = 1$, an r of .96, for example, has Σ^2_{max} and Σ^2_{min} equal to $(1+r)$ and $(1-r)$ or 1.96 and .04, respectively. However, Σ^2_{min} need not be measured, since, having obtained σ_1^2, σ_2^2 and Σ^2_{max} in the machine, it is determined by Yule's first equation above. This relation should also be useful in checking and in calibrating the machine.

The method appears to warrant experimental work because, given a device adapted to these problems, the determination of a coefficient would require only that a few measurements be taken from the correlation surface. Presumably an operator provided with tables appropriate to the method should be able to report a plotted coefficient, together with means and standard deviations, in less time and with greater likelihood of accuracy than seems possible by methods of standardizing correlational arithmetic.

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MEDICO-GENETICAL INSTITUTE
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DENATURIZING FORMALDEHYDE

MANY of us who work in anatomy and pathology laboratories and others who work with material preserved in formaldehyde solutions have often wished that the irritating properties of the formaldehyde could be overcome. Recently there appeared in SCIENCE (Vol. 73: 495–496; 675) two discussions covering the disagreeable effects of formalin and a method which in a measure would reduce some of these effects.

In our laboratories we have been able to counteract to a very satisfactory degree some of the objectionable effects of formaldehyde. Museum specimens preserved in formaldehyde solution (4 per cent. to 10 per cent. formalin in water) and dissection material so preserved have been removed from the preservative, washed in water, then submerged for 15 to 30 minutes in an aqueous solution containing 5 per cent urea and 1 per cent. ammonium phosphate. Before returning to the original formaldehyde preservative the specimens were again rinsed in water to remove any free urea. Many repetitions of the method have failed to show any bad effects on the tissues so treated. During a period of 3 to 4 hours dissection or demonstration subsequent to the treatment no irritating effects from formaldehyde were evident.

In applying this process to our embalming procedure, we have used as our regular embalming solution: Formalin, 12 to 20 per cent.; glycerol, 10 per cent.; potassium nitrite, 0.1 per cent.

The embalmed cadavers have been kept for various periods previous to dissection. One or two days before the cadavers are turned over to the students a cold cornstarch-red-lead mass containing 5 per cent. urea has been injected into the arterial system. One difficulty with the method is that mold growth appears to be enhanced and greater vigilance in mold control is necessary. To combat the mold growth, we have had success only with topical applications of known fungicides.

The atmosphere of the dissecting room has been remarkably free from formaldehyde following the application of the method described, and the irritating effects of formalin on the skin and mucous membranes of the students and instructors have been almost nil.

The experiments upon which these observations were based were largely financed by a grant from the Graduate College.

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